SCIENCE

FRIDAY, DECEMBER 1, 1899.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE ASTRONOMICAL AND ASTROPHYSICAL SOCIETY OF AMERICA.

I.

THE third conference of Astronomers and Astrophysicists was held at the Yerkes Observatory, in Williams Bay, Wisconsin, on September 6, 7 and 8, 1899, in accordance with arrangements made by a committee appointed at the second conference, held at Harvard College Observatory in August of last year. This committee, consisting of Professors Newcomb, Pickering, Morley, Comstock and Hale, had also been authorized to prepare a constitution and arrange for the organization of a permanent society. At the second session of the conference the constitution was adopted, substantially as presented by the committee, and at the last session, on September 8th, the organization was completed with the election of the following officers:

President, Simon Newcomb; Vice-Presidents, C. A. Young, G. E. Hale; Secretary, G. C. Comstock; Treasurer, C. L. Doolittle; Councilors, for two years, E. C. Pickering, J. E. Keeler; Councilors, for one year, E. W. Morley, Ormond Stone.

The undersigned will temporarily act as Secretary.

At a subsequent meeting of the Council by-laws were adopted. It was further voted that a report of the proceedings should be furnished for publication in SCIENCE, to-

gether with abstracts of the papers, prepared by the authors and edited by the Secretary. It is not intended that the Society shall maintain a library, and an exchange of publications with other societies is not expected. The assessment for the current year was set at two dollars. The Secretary was authorized to arrange for a meeting of the Society in New York City in connection with the meeting of the American Association for the Advancement of Science. The charter members number one hundred and fourteen, consisting of those attending the second or third conference who signed a statement of desire that a society be formed and of those who otherwise expressed to the committee or Council their wish to join when the society should be organized.

The constitution and by-laws follow :

CONSTITUTION.

ARTICLE I.—*Name and Purpose.*

1. This association shall be called The Astronomical and Astrophysical Society of America.

2. The purpose of this Society is the advancement of astronomy, astrophysics, and related branches of physics.

ARTICLE II.—*Membership.*

1. Those persons whose names were signed on or before September 15, 1899, to the annexed statement of desire to form such an association shall constitute the charter members of this Society. Other persons may be elected to membership in the Society by the Council hereinafter provided.

2. The Council shall prepare and publish in the form of a by-law uniform rules for the government of such elections.

ARTICLE III.—*Officers.*

1. The officers of the Society shall consist of a president, two vice-presidents, a secretary, and a treasurer, who, in addition to the duties specifically assigned them by this constitution, shall discharge such other duties as are usually incident to their respective offices. These officers, together with four other members of the Society, shall constitute a Council to which shall be entrusted the management of all affairs of the Society not otherwise provided for. The president and secretary of the Society shall serve respectively as chairman and secretary of the Council, and every officer of the Society shall be responsible to the Council and shall administer his office in accordance with its instructions.

2. The Council shall enact such by-laws as may be found needful and proper for administering the affairs of the Society, and may from time to time modify or repeal such by-laws.

3. The president, the vice-presidents and the treasurer shall be elected annually in a manner to be prescribed by the Council, and shall serve until their successors are duly elected and qualified. Two members of the Council shall be chosen at the first annual meeting of the Society to serve for a period of one year, and two members shall be chosen annually to serve for a period of two years or until their successors are duly elected and qualified. The term of office of the secretary shall be three years or until his successor is duly elected and qualified.

ARTICLE IV.—*Meetings.*

1. The Council shall determine the time and place of each meeting of the Society and shall provide for an annual meeting, at which officers shall be elected.

2. The Council shall have charge of the programme for each meeting.

3. At meetings of the Society, regularly called, twenty members shall constitute a quorum.

ARTICLE V.—*Finance.*

1. The Council shall levy an annual assessment upon the members of the Society sufficient to provide the funds required by the Society for the ensuing year ; provided that this assessment shall not exceed the sum of five dollars per member in any year.

2. If at any time there shall be required for the purposes of the Society a larger sum than can be obtained in accordance with Section 1 of this article, the Council shall present at an annual meeting of the Society a statement of such need and of the circumstances attending it, and the Society shall thereupon determine by ballot a policy to be adopted in the matter.

3. No officer of the Society shall receive any compensation for services rendered to it, but the Council may by resolution direct the treasurer to reimburse to any officer expenses necessarily incurred by him in the discharge of his official duty.

ARTICLE VI.—*Amendments.*

1. This constitution may be amended by the affirmative votes of three-fourths of the members present at any annual meeting of the Society, but no amendment shall be voted upon unless a notice setting forth the nature of such proposed amendment shall have

been forwarded to the several members of the Society at least one month before the meeting at which it is proposed to be voted upon.

2. It shall be the duty of the secretary to forward such notices of a proposed amendment to this constitution, when so requested in writing by ten members of the Society.

BY-LAWS.

1.—*Election of Members.*

Any person deemed capable of preparing an acceptable paper upon some subject of astronomy, astrophysics, or related branch of physics, may be elected by the Council to membership in the Society upon nomination by two or more members of the Society. At least once in each year the Council shall consider all such nominations and may request the opinion of persons not members of the Council with reference to the qualifications of the nominees. Blanks for such nominations to membership shall be furnished by the secretary.

2.—*Election of Officers.*

The Council shall provide for holding upon the day preceding the last day of each annual meeting a nominating ballot at which each member of the Society may deposit his ballot for each officer to be elected for the ensuing year. Members not in attendance at such annual meeting may send to the secretary their ballots enclosed in a sealed envelope bearing the signature of the voter. The vice-presidents, or in their absence, tellers appointed by the chair, shall canvass the ballots thus cast, and shall prepare and present to the Society a list showing the three persons who have received the largest number of votes for each office to be filled. In case of a plurality of names receiving the same number of votes in third place, all the names in such plurality shall be included in the list.

Upon the last day of each annual meeting written ballots shall be cast by the individual members of the Society for filling each office about to become vacant, of which only those shall be counted which are cast for persons nominated in the lists prepared as above directed for the office in question or for some higher office.

The nominee receiving the greatest number of votes for any office shall be thereby elected and shall be notified of such election in writing, by the secretary, within ten days thereafter. It shall be the duty of each person thus notified to file with the secretary his written acceptance of such office, and if such acceptance is not filed within sixty days after notification the Council by resolution may declare such office vacant and may elect any member of the Society to fill it until the close of the next annual meeting.

3.—*Treasurer.*

The treasurer of the Society shall keep accounts showing all receipts and expenditures of moneys belonging to the Society, and showing also the indebtedness to the Society of each member thereof, on account of unpaid assessments. These accounts shall be submitted at each annual meeting to an auditing committee, of not less than three members, to be appointed by the Council. The secretary shall be *ex-officio* a member of this committee.

4.—*Secretary.*

The secretary shall be the purchasing officer of the Society and the treasurer shall be the disbursing officer, but the total amount expended by the secretary and treasurer without previous authority from the Council shall not exceed the sum of fifty dollars in any year.

5.—*Unpaid Assessments.*

The treasurer shall report to the Council at each annual meeting a list of all members indebted to the Society on account of unpaid assessments.

6.—*Order of Business.*

The following order of business is prescribed for meetings of the Council :

a. Call to order by the chair.
b. Reading of minutes of last meeting.
c. Announcements by the chair.
d. Announcements by the secretary.
e. Announcements or reports by other officers.
f. Unfinished business.
g. New business.
h. Miscellaneous.
i. Adjournment.

The conference was attended by about fifty representatives of astronomy and physics. Professor Harkness presided over the sessions.

The following are abstracts of the papers presented, prepared as stated above :

S. J. BROWN : *Position of the Polar Axis and the Flattening of Neptune from the changes in orbit of its Satellite.*

The large changes which had been observed in the longitude of the node and the inclination of the orbit plane of Neptune's satellite referred to the earth's equator were explained by Tisserand on the as-

sumption of only a moderate polar compression of the planet. The orbits based upon the measures of Professors Newcomb, Hall, Holden, Hermann Struve and A. Hall, Jr., were best satisfied by a uniform, progressive change of the above elements. From a series of observations by Barnard in 1897–98, and another by himself, the author has been enabled to show that there is a variation in the rate of this change. The result of a least square solution from all the available elements from 1848 to 1898 was given in a table. Although the residuals are but slightly smaller than would result from the assumption of a uniform rate, this is chiefly due to the inaccuracy of the earlier elements. The validity of a variable rate is further confirmed by an apparent increase in the mean motion of the satellite referred to the movable node of the orbit plane on the Earth's equator, which is otherwise difficult to explain. The equatorial protuberance of the planet will cause the pole of the satellite's orbit to describe, with uniform retrograde motion, a small circle around the pole of the planet's equator considered as a fixed point, while the inclination of the two planes will remain constant. The node of the satellite's orbit on the planet's equator will thus move uniformly along the latter, in a direction contrary to the motion of the satellite. The differential equations of this motion were given.

A least square solution of 36 equations of condition gave the following elements of the planet's equator:

$$\left.\begin{array}{ll} \gamma & 17^\circ.84 \\ I_0 & 49^\circ.38 \\ \theta_0 & 119^\circ.16 \\ N_0 & 22^\circ.02 \\ \Delta\theta & 0^\circ.677 \end{array}\right\} \text{Equator of 1850.0}$$

$$\text{The flattening is } \epsilon = \frac{1}{102.2}.$$

The period of the revolution of the pole of the satellite's orbit is 531.75 years. The flattening is a quantity represented by a difference of only 0''.03 between the polar and equatorial diameters of the planet—a quantity scarcely measurable in the most powerful telescope.

(To be published in the *Astronomical Journal.*)

A. S. Flint: *The Repsold Transit Micrometer of the Washburn Observatory and Slat Screen Apparatus.*

The transit micrometer is at present employed on the meridian circle, of 12.2 cm. aperture, in a new series of observations for stellar parallaxes by the method of meridian transits. The essential feature of the instrument is an auxiliary screw which is geared with the regular right ascension screw and carries the eye-piece to follow the movable thread. The observer keeps a star image bisected continuously by means of two turning heads on this auxiliary screw, one on each side of the micrometer box, while a series of contact points on the head of the right ascension screw effect the electric signals on the chronograph. The present observer finds the probable error of a single signal to be 0.030s., the same as in the ordinary method with fixed threads.

This micrometer has also a device for obtaining a record of several bisections on a given star in declination without the necessity of reading the micrometer head. A lever clamped to the declination screw travels over a short graduated arc and, being pressed down by the observer, pricks a mark on a strip of paper.

Some suggestions were made for minor improvements, but the performance of the micrometer as a whole has been found very satisfactory.

The slat screen apparatus, designed by Professor Comstock, is intended to furnish the simplest means of diminishing the apparent magnitude of brighter stars. A frame

clamped to the objective end of the telescope bears a series of five slats, each 25 mm. wide, in front of the objective. These slats rotate about their longitudinal axes and are so connected as to turn together by means of a wire cord passing over a pulley near the eye end of the telescope. The entire attachment at the objective end is made of aluminium, and the total weight added to the telescope is 27 oz. (0.76 kg.). As viewed with the slats partly turned, a bright star appears as a central stellar image with a line of spectral images extending on either side at right angles to the direction of the slats. Comparisons indicate that this novel appearance has no influence upon the probable error of a single chronographic signal.

E. E. BARNARD: *Triangulation of Star Clusters.*

From the advantages given by the great scale of the 40-inch, it was decided to measure the positions of a number of stars in some of the globular clusters, as a basis for the study of their motions in the future. For this purpose the clusters M 3, M 5, M 13, M 15 and M 92 were selected as representative.

In comparison with Scheiner's photographic measures of M 13 it was found that several of the stars had either diminished very greatly in brightness of late years, or that their light must come mostly from the blue end of the spectrum. The stars, 382 and 393, of his list, are striking examples. Both these stars are given by him as 12.7 magnitude. Visually, the first, which is his normal star, cannot be brighter than the 15th magnitude, while the second is at the limit of the great telescope and has been seen a few times only. Though it is possible that these stars may be variable, the observations do not seem to show it, except possibly in the case of No. 393.

Variable Stars in Clusters.

Some of the small variable stars discovered by Professor Bailey have been regularly observed during the measures of that cluster. Besides the small variables there are three rather bright stars in this cluster which are also variable. Two of these were discovered eight or ten years ago by Mr. C. D. Packer, of London. These three stars vary slowly, requiring upwards of a month for their variations, and one of them has a much longer period. The small stars, however, are very rapid in their changes, with nearly the same periods, averaging, as Professor Bailey has shown, about half a day. Variable No. 33, which rises from the 15th to about the 14th magnitude, and whose period is 12 hours 1 minute, has been specially observed at the request of Professor Bailey. The observations show that this object lies dormant for a large portion of its period as a faint star of the 15th magnitude. It suddenly begins to brighten, and in about 15 minutes has doubled its light; it then slowly declines to a position of rest.

Several new variables were found in this cluster that are not marked on the Harvard photographs.

The Fifth Satellite of Jupiter.

The fifth Satellite of Jupiter was observed with the 40-inch, both in 1898 and 1899, and good measures obtained of it. From the elongation distances obtained at these observations, a new value for the motion of the line of apsides of the orbit was determined. This was found to amount to 900° a year, or a complete revolution of the orbit in 4.9 months. With this value of the motion of the perijove, all the elongation distances observed for the past seven years were accurately represented. A new determination was also made of the periodic time which is 11 h. 57 m. 22.647 s. As this period was derived from nearly five

thousand revolutions it is probably very accurate.

The Annular Nebula in Lyra.

A number of the Planetary Nebulæ have been observed and measured. The position of the nucleus of the annular Nebula of Lyra (M 57) was carefully measured in 1898 and 1899. These, compared with Mr. Burnham's measures in 1891 with the 36-inch of the Lick Observatory, seem to show a sensible proper motion for the whole of about 0″.13 annually. This can be verified with certainty by measures four or five years hence.

The small stars near this nebula measured by Professor Hall at Washington in 1877, have been remeasured and the observations show that one of these stars (*f* of Hall's list) of the 15th magnitude seems to have a considerable proper motion.

Difference of Declination of Atlas and Pleione.

The summers and winters of Williams Bay subject the 40-inch to extreme ranges of temperature. Micrometer measures were made in all temperatures between + 80° F. and − 26° F. These observations showed that the focus of the great objective changed to the extent of about 0.7 inch—shortening with the cold weather. To test these changes, a great number of measures of the difference of declination of Atlas and Pleione of the Pleiades, had been made in 1897, 1898 and 1899. These measures besides showing considerable temperature changes, also show some peculiarities not satisfactorily accounted for and which do not show in similar measures of Electra and Caeleno, and which could be explained by a slight oscillation in the position of one of the stars. It is intended to further continue these measures.

ORMOND STONE: *On the Motion of Hyperion.*

If, in the first approximation the motion of the perisaturnium of Hyperion be assumed to be $4n'-3n$, in which n and n' are the instantaneous mean motions in longitude of Titan and Hyperion, the perturbative function will contain an expression of the form

$$C_1 \{e_0 + e' [1 + \cos (4l' - 3l - \pi')]\}, \quad (1)$$

in which C_1 is a function of the mass of Titan and the mean distances from Saturn of Titan and Hyperion, e_0 is the quasi-eccentricity of the orbit of Hyperion introduced by the erroneous assumption in regard to the mean motion of the perisaturnium, e' and π' are the eccentricity and longitude of perisaturnium properly so-called, and l' and l are the longitudes in orbit of Hyperion and Titan, the motions of the two bodies being considered co-planar.

Integration, assuming the values of the coefficients given by Newcomb in his 'Astronomical Papers,' Vol. III., and comparison with Eichelberger's value of the inequality in mean longitude detected by Hermann Struve, result in two solutions, giving rise to two sets of values for m, the mass of Titan, and e':

$$m = \frac{1}{5000}, \qquad e' = 0.0224;$$

$$m = \frac{1}{4370}, \qquad e' = 0.0195.$$

As neither of these values of m differs greatly from the more reliable values found hitherto, it is uncertain which of the solutions is the correct one, and we can only say, at present, that the true value of the eccentricity of the orbit of Hyperion probably does not differ greatly from 0.02.

W. W. CAMPBELL: *The Variable Velocity of Polaris in the Line of Sight.*

Polaris furnishes an interesting case of variable velocity in the line of sight. Six spectrograms were obtained in 1896, as follows:

Gr. M. T. 1896, Sept.	8^d 22.8^h	—20.1 km.
"	15 22.8	—19.1
"	23 21.4	—18.9
Oct.	5 21.0	—19.0
Nov.	11 19.3	—20.1
Dec.	8 16.7	—20.3
	Mean	—19.6

The agreement of these results was satisfactory, and gave no evidence of variable velocity.

In order to test the current results of our work, another photograph of the spectrum of Polaris was obtained on Aug. 8, 1899. This yielded a velocity of —13.1 km., and led to the suspicion that we were dealing with a variable. Two additional plates were secured on August 9th and 14th, which yielded velocities of —11.4 and —9.0 km., respectively. Inasmuch as a range of 4 km. is not permissible in the case of such an excellent spectrum, the star was suspected to be a short period variable, and further observations were obtained, as below:

Gr. M. T. 1899	Velocity	Measured by
August 9^d 0.8^h	—13.1	Campbell
9 20.1	—11.4	Campbell
14 22.8	— 9.0	Campbell
16 0.1	—14.1	Campbell
23 0.3	—10.9	Campbell
24 0.8	—15.2	Campbell
26 0.9	— 9.4	Campbell
*	— 8.6	Wright
27 0.3	—10.6	Campbell
27 16.2	—14.0	Campbell
28 0.8	—14.7	Campbell
*	—14.3	Wright
28 16.3	—13.7	Wright
29 0.4	—12.1	Wright
29 18.8	— 9.6	Wright
30 0.0	— 8.9	Wright
30 16.2	— 9.3	Wright

* Measures of the same plate by Mr. Wright.

On plotting these observations it became evident that Polaris is a spectroscopic binary, having a period a little less than four days. The 1899 observations have been collected and plotted on the assumption that the period is 3^d 23^h. The velocity, at present, seems to be included between —8.6 and —14.6 km., having an extreme range of only 6 km. The velocity of the binary system seems to be about 12 km.

The determinations of velocity made in 1896 lie entirely outside of the present range of values, and leave no doubt that the velocity of the binary system is changing under the influence of an additional disturbing force. I think it is certain, therefore, that Polaris is at least a triple system.

The 1896 observations were made at intervals differing but little from multiples of the period of the binary system, and therefore fell near the same point in the velocity curve. Assuming a period of 3^d 23^h $\pm$, there is no difficulty in selecting the epoch of minimum so that these six observations will fall on the curve satisfying the 1899 observations. The residuals will be negligible if we assume the observations to fall near the lower part of the curve; and I have no doubt that future determinations of the orbit will definitely place them there. It will be seen that the velocities of the binary system in 1896 and in 1899 differ about 6 km.

The Spectroscopic Binary Capella.

An examination of six spectrum plates of *a Aurigæ*, obtained with the Mills' Spectrograph in 1896–7, leaves no doubt that this star is a spectroscopic binary. The spectrum is composite. The component whose spectrum is of the solar type furnished the following velocities with reference to the solar system:

1896,	Aug. 31	+ 34 km.
	Sept. 16	+ 54
	Oct. 3	+ 49
	Oct. 5	+ 44
	Nov. 12	+ 4
1897,	Feb. 24	+ 3

On the first photograph the spectrum is of essentially normal solar type; on the

others it is unmistakably different. There appears to be a second component whose spectrum contains the $H\gamma$ line and the rather prominent iron lines. On the plates of September 16th, October 3d and October 5th, these lines are shifted toward the violet with reference to the solar type spectrum; and in the spectra of November 12th, and February 24th they are shifted toward the red. (Papers published in *Astrophysical Journal.*)

KURT LAVES: *On the Determination of the Constant of Nutation from Heliometer Observations of Eros.*

The opposition of Eros at the end of next year will grant very valuable material for the determination of N, the constant of nutation. In No. 3,156 of the *A. N.*, I have pointed out that this constant could be well determined from heliometer observations of such small planets as come nearer to the earth than the astronomical unit. In the discussion of the heliometer observations of Victoria, made for the purpose of deriving a reliable value of the mean solar parallax, Dr. Gill has carried out this plan. He has found $N = 9''.2068 \pm 0''.0034$ (see Annals of the Cape of Good Hope, Vol. VI., part 6). This result agrees excellently with the value of N derived from direct observations. The reason for this agreement is due to Dr. Gill's new value derived for L, the constant of lunar equation. Indeed, in a former attempt to obtain N by this method, I had employed Leverrier's value $L = 6''.50$, and I was led to a value of $N = 9''.26$. The classical work of Dr. Gill has shown, beyond doubt, that the correct value of L is much smaller; Dr. Gill gives for it $6''.414 \pm 0''.009$. With this value he has obtained the result mentioned above. The quantities on which the final determination of N depends are: the constant of luni-solar precession p^0, the mean solar parallax π^0, the constant of lunar equation L, and the inclination of the moon's orbit to the ecliptic c. We find

$$dN = 0.45\,dL - 0.34\,d\pi^0 + 0.17\,dp^0 + 0.002\,dc.$$

It is thus evident that the small probable error of L in Dr. Gill's value has mainly reduced the formerly large probable error of N. We may regard that the probable errors of L, π^0, p^0, c are as follows:

$$\Delta L = \pm 0''.009; \quad \Delta\pi^0 = 0''.005; \quad \Delta p^0 = 0''.004; \quad \Delta c = 1''.$$

ΔL and $\Delta\pi^0$ are the values obtained from the heliometer observations of Victoria. The smallest geocentric distance of this small planet was 0.82. The greatest geocentric displacement observable for the purpose of determining L was $15''$ (this displacement is due to the semi-monthly translatory motion of the Earth's center about the center of gravity of the System Earth-Moon).

During the next opposition of Eros this planet will be at a mean geocentric distance of 0.34 for about eight weeks, the displacement witnessed will amount to about $37''$. From this it is evident that a systematic series of heliometer observations of this interesting object, will both give us a much more accurate value of π^0 and grant an excellent redetermination of L. It is found that the magnitude of Eros will vary between 8.8 and 9.7 during this time. The most favorable opposition possible for Eros will reduce the geocentric distance to 0.15. Assuming the mean distance for two weeks to be 0.20 we shall have an angle of nearly $64''$ available for heliometric measurements.

Inner Potential Forces in Astronomy.

In No. 445 of the *Astronomical Journal* an investigation was published concerning the

ten integrals of the problem of n bodies for forces involving the coördinates and their first and second differential quotients. The conclusion was reached that the new potential function W must be an arbitrary function of the mutual distances and relative velocities of the n bodies and must not contain the time explicitly, in order that the ten integrals should hold. In a communication to the Academy of Sciences of Leipzig on Jan. 9, 1899, Professor A. Mayer, of Leipzig University, has recently taken up the same problem. His investigation deals with the problem in a more general way and has brought to light an oversight of mine in the above definition of W. Following this W should, in addition to the arguments mentioned above, contain the differential quotients of the mutual distances. It is my intention to give a detailed account of Professor Mayer's paper in one of the next issues of the *Astronomical Journal*.

A. HALL, JR.: *The Aberration Constant from Meridian Zenith Distances of Polaris.*

A series of measures was begun by the author with the meridian circle of the Detroit observatory of meridian zenith distances of Polaris, with the idea of determining the aberration constant and the latitude variation.

Measures were made above and below the pole, direct and reflected, but the number of reflected observations has been rather small. A rough reduction of the observations made between May 1898, and July 1899, gives the following values for the aberration constant:

	Direct.	Reflected.
Upper culmination	20″.60	20″.66
Lower culmination	20 .58	20 .40

M. B. SNYDER: *The Phonochronograph, and its Advantages in Certain Astronomical Observations.*

In all kinds of astronomical observations, where phenomena, especially of an unpredicted character, rapidly succeed each other, it has invariably been found extremely difficult to make time records that can subsequently and with certainty be identified with the phenomena. Even with tried assistants as recorders, and with a prearranged code of chronographic signals there is usually a double failure; first, the proper records are not made by the assistants, and secondly, the time signals can not be satisfactorily identified.

The phonochronograph, as for brevity I designate a high grade phonograph also transformed into an efficient chronograph, seems fully to obviate the difficulties mentioned. The instrument records any vocal expression made by the observer along with a simultaneous sound automatically produced every second or two by the clock or chronometer. The record both for time, and for character of phenomena, is unbiased, absolutely identifiable, and can be read off without introducing any reaction time, excepting that originally entering.

The instrument consists of a phonograph whose cylinder rotates uniformly, and whose sliding carriage, which by turns bears both the recorder and the receiver, also has attached, near a second mouthpiece, a small electromagnet whose armature is attached to a light wooden hammer, which at each closure of the electrical circuit by the clock, strikes a small resonating box placed opposite the second mouthpiece. With properly selected resonating box, it is found that not only can the time signal always be read off by ear as distinct from the vocal record, but be visually distinguished as well. For the purpose of reading off the time record, so as not again to interpolate a reaction time, the sliding carriage also bears a microscope of moderate power, which is placed at an angle of about 90 degrees back of the recording diaphragm and

enables one clearly to distinguish the clock from the vocal records. To enable the angular distance between the clock record and any given vocal record to be read off, a graduated circle, with stationary index, is attached to the end of the phonographic cylinder. The instrument is also provided with a rotameter, which rests on the surface of the cylinder and indicates the linear, instead of the angular, distance between records.

With present chronographic appliances it is feasible to construct a phonochronograph that will run for ten minutes, and it seems mechanically possible to treble this at least.

In observations of the meteors, where unexpected features occur, and particularly in solar eclipses, the phonochronograph seems to possess peculiar advantages. It is also suggested that the usual seconds-counting done by an assistant during totality can be done, without any special sacrifice or nervousness, by a phonographic cylinder previously prepared.

G. W. HOUGH: *Actinism of Moonlight in a Total Eclipse.*

Near the middle of the total eclipse of the moon, on December 27, 1898, two negatives were made with the finder telescope, on a Seed 27 plate, with an exposure of five minutes each.

The resulting negatives gave good printing density.

Near the end of totality it clouded, but on the following night a number of negatives were made with the same telescope with reduced apertures.

It was found that an aperture of 0.16 inch, and an exposure of ten seconds gave a negative similar to that made during the eclipse.

From these experiments the actinism or photographic power of the eclipsed moon was found to be $\frac{1}{17000}$ that of the uneclipsed moon. The eclipsed moon was not equally luminous, and the photographic power might range between $\frac{1}{17000}$ and $\frac{1}{30000}$.

Young's General Astronomy gives the photographic power of the eclipsed moon of January 28, 1888, as determined by Professor Pickering, as $\frac{1}{1\,400\,000}$ that of the uneclipsed moon.

I had intended to determine definitely, with my sensitometer, the total actinism of the eclipsed moon, but the exposures which were made for me by a student in astronomy were all too short to be of use.

In 1892 I published a table giving the relative sensitiveness of a considerable number of commercial dry plates for sunlight, candle light, and through red glass. For the rapid plates it was found that the color-sensitized plates were twice as sensitive in the yellow and eight times as sensitive in the red as the ordinary plates.

As the light of the eclipsed moon is always colored, it is obvious that its actinism or photographic power will depend on the kind of plate employed; and possibly on its manipulation previous to development, owing to the effect of preliminary or supplementary exposure.

GEORGE E. HALE: *Carbon in the Chromosphere.*

The level at which carbon vapor exists in the atmosphere of the sun was definitely ascertained in 1897 with the 40-inch Yerkes telescope, when the green carbon (or hydrocarbon) fluting was found in the spectrum of the chromosphere. The layer of carbon vapor to which the fluting is due is not more than a second of arc in thickness, and lies in immediate contact with the photosphere. For this reason it can be observed only with the most powerful telescopes, used under the most perfect atmospheric conditions. The fluting has been repeatedly seen at the Yerkes Observatory during the past summer, and its individual lines identified

with the dark lines in the solar spectrum ascribed by Rowland to carbon. On August 17th the yellow carbon fluting, which is more difficult than the green fluting, was also found. These observations reveal an interesting similarity of the sun to red stars of Secchi's fourth type, in which a dense absorbing atmosphere of carbon (which is far more conspicuous than in the sun) has recently been found with the 40-inch telescope to be surmounted by an atmosphere giving a spectrum of bright lines.

Some New Forms of Spectroheliographs.

Of the various forms of spectroheliographs described in my previous papers, the simplest and best is undoubtedly that in which the instrument is moved as a whole at right angles to the axis of the telescope, the solar image and photographic plate remaining stationary. It is not always possible, however, to employ a spectroheliograph of this form. With the forty-inch telescope, for example, the motion of the very heavy spectroheliograph required could not be accomplished without jarring the instrument. For this reason it has been decided to cause the solar image to move across the first slit by means of the slow motion declination motor. The first and second slits are fixed with reference to each other, and the photographic plate is moved across the second slit by means of a screw driven by the same motor, which is mounted on the tube of the forty-inch telescope. A wide range of exposures can be secured by means of a system of change gears. This spectroheliograph, which has an aperture of 6¼ inches, is now nearly ready for trial.

Two other forms of spectroheliographs may occasionally prove useful. The solar image is moved across the first slit in the one case by means of a photographic doublet, of large field, mounted between the slit and the principal focal plane of the image lens, and in the second case by means of a right angle prism, placed immediately in front of the first slit, with hypothenuse face parallel to the optical axis of the collimator. A suitable combination of mirrors may be used instead of the prism. The doublet or prism are connected with a carriage bearing the photographic plate across the second slit, and are moved in a direction at right angles to the optical axis of the collimator. Either device, used in conjunction with a heliostat, affords an easy means of transforming a large fixed laboratory spectroscope, of almost any type, into a spectroheliograph.

Comparison of Stellar Spectra of the Third and Fourth Types.

As previous observations of the faint red stars of Secchi's fourth type have shown none of the lines in their spectra it has been impossible to effect any satisfactory comparison of these stars with the red stars of the third type. So far as their characteristic features go, the spectra are quite dissimilar, the pronounced carbon absorption bands of the fourth type having no counterpart in the banded spectra of the third type stars. The photographs of these spectra recently obtained with the forty-inch telescope, by Mr. Ellerman and the writer, contain hundreds of lines, and render comparisons possible. From these plates it has been found that in certain limited regions third and fourth type spectra are almost identical. It is, therefore, probable that the stars of these two great classes are closely related to each other and to stars like the Sun. The study of fourth type stars is being continued at the Yerkes Observatory.

(*To be continued.*)

EDWIN B. FROST,
Acting Secretary.

YERKES OBSERVATORY,
WILLIAMS BAY, WIS.

ADDRESS OF THE PRESIDENT BEFORE THE SECTION OF GEOGRAPHY OF THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

II.

Evolution of the Continental and Oceanic Areas.

I have now pointed out what appear to me to be some of the more general results arrived at in recent years regarding the present condition of the floor of the ocean. I may now be permitted to indicate the possible bearing of these results on opinions as to the origin of some fundamental geographical phenomena; for instance, on the evolution of the protruding continents and sunken ocean-basins. In dealing with such a problem much that is hypothetical must necessarily be introduced, but these speculations are based on ascertained scientific facts.

The well-known American geologist, Dutton, says: "It has been much the habit of geologists to attempt to explain the progressive elevation of plateaus and mountain platforms, and also the folding of strata, by one and the same process. I hold the two processes to be distinct, and having no necessary relation to each other. There are plicated regions which are little or not at all elevated, and there are elevated regions which are not plicated." Speaking of great regional uplifts, he says further: "What the real nature of the uplifting force may be is, to my mind, an entire mystery, but I think we may discern at least one of its attributes, and that is a gradual expansion or diminution of density of the subterranean magmas. * * * We know of no cause which could either add to the mass or diminish the density, yet one of the two must surely have happened. * * * Hence I infer that the cause which elevates the land involves an expansion of the underlying magmas, and the cause which depresses it is a shrinkage of the magmas; the nature of the process is at present a complete mystery." I shall endeavor to show how the detailed study of marine deposits may help to solve the mystery here referred to by Dutton.

The surface of the globe has not always been as we now see it. When, in the past, the surface had a temperature of about 400° F., what is now the water of the ocean must have existed as water vapor in the atmosphere, which would thereby—as well as because of the presence of other substances—be increased in density and volume.

Life, as we know it, could not then exist. Again, science forsees a time when low temperatures, like those produced by Professor Dewar at the Royal Institution, will prevail over the face of the earth. The hydrosphere and atmosphere will then have disappeared within the rocky crust, or the waters of the ocean will have become solid rock, and over their surface will roll an ocean of liquid air about forty feet in depth. Life, as we know it, unless it undergoes suitable secular modifications, will be extinct. Somewhere between these two indefinite points of time in the evolution of our planet it is our privilege to live, to investigate, and to speculate concerning the antecedent and future conditions of things.

When we regard our globe with the mind's eye, it appears at the present time to be formed of concentric spheres, very like, and still very unlike, the successive coats of an onion. Within is situated the vast nucleus or *centrosphere;* surrounding this is what may be called the *tektosphere,** a shell of materials in a state bordering on fusion, upon which rests and creeps the *lithosphere.* Then follow *hydrosphere* and *atmosphere,* with the included *biosphere.*† To the interaction

* τηκτός, molten.

† βιος.

of these six geospheres, through energy derived from internal and external sources, may be referred all the existing superficial phenomena of the planet.

The vast interior of the planetary mass, although not under direct observation, is known, from the results of the astronomer and physicist, to have a mean density of 5.6, or twice that of ordinary surface rock. The substances brought within the reach of observation in veinstones, in lavas, and hypogene rocks—by the action of water as a solvent and sublimant—warrant the belief that the centrosphere is largely made up of metals and metalloids with imprisoned gases. It is admitted that the vast nucleus has a very high temperature, but so enormous is the pressure of the super-incumbent crust that the melting-point of the substances in the interior is believed to be raised to a higher value than the temperature there existing—the centrosphere in consequence remains solid, for it may be assumed that the melting-point of rock-forming materials is raised by increase of pressure. Astronomers from a study of precession and nutation have long been convinced that the centrosphere must be practically solid.

Recent seismological observations indicate the transmission of two types of waves through the earth—the condensational-rarefactional and the purely distortional—and the study of these tremors supports the view that the centrosphere is not only solid, but possesses great uniformity of structure. The seismological investigations of Professors Milne and Knott point also to a fairly abrupt boundary or transition surface, where the solid nucleus passes into the somewhat plastic magma on which the firm upper crust rests.

In this plastic layer or shell—named the *tektosphere*—the materials are most probably in a state of unstable equilibrium and bordering on fusion. Here the loose-textured solids of the external crust are converted into the denser solids of the nucleus or into molten masses, at a critical point of temperature and pressure; deep-seated rocks may in consequence escape through fissures in the lithosphere. Within the lithosphere itself the temperature falls off so rapidly towards the surface as to be everywhere below the melting-point of any substance there under its particular pressure.

Now, as the solid centrosphere is slowly contracted from loss of heat, the primitive lithosphere, in accommodating itself—through changes in the tektosphere—to the shrinking nucleus, would be buckled, warped, and thrown into ridges. That these movements are still going on is shown by the fact that the lithosphere is everywhere and at all times in a slight but measureable state of pulsation. The rigidity of the primitive rocky crust would permit of considerable deformations of the kind here indicated. Indeed, the compression of mountain chains has most probably been brought about in this manner, but the same cannot be said of the elevation of plateaus, of mountain platforms, and of continents.

From many lines of investigation it is concluded, as we have seen, that the centrosphere is homogeneous in structure. Direct observation, on the other hand, shows that the lithosphere is heterogeneous in composition. How has this heterogeneity been brought about? The original crust was almost certainly composed of complex and stable silicates, all the silicon dioxide being in combination with bases. Lord Kelvin has pointed out that, when the solid crust began to form, it would rapidly cool over its whole surface; the precipitation of water would accelerate this process, and there would soon be an approximation to present conditions. As time went on the plastic or critical layer—the tektosphere—immedi-

ately beneath the crust would gradually sink deeper and deeper, while ruptures and readjustments would become less and less frequent than in earlier stages. With the first fall of rain the silicates of the crust would be attacked by water and carbon dioxide, which can at low temperatures displace silicon dioxide from its combinations. The silicates, in consequence, have been continuously robbed of a part, or the whole, of their bases. The silica thus set free goes ultimately to form quartz veins and quartz sand on or about the emerged land, while the bases leached out of the disintegrating rocks are carried out into the ocean and ocean-basins. A continuous disintegration and differentiation of materials of the lithosphere, accompanied by a sort of migration and selection among mineral substances, is thus always in progress. Through the agency of life, carbonate of lime accumulates in one place; through the agency of winds, quartz sand is heaped up in another; through the agency of water, beds of clay, of oxides of iron and of manganese are spread out in other directions.

The contraction of the centrosphere supplies the force which folds and crumples the lithosphere. The combined effect of hydrosphere, atmosphere, and biosphere on the lithosphere gives direction and a determinate mode of action to that force. From the earliest geological times the most resistant dust of the continents has been strewn along the marginal belt of the sea-floor skirting the land. At the present time the deposits over this area contain on the average about 70 per cent. of free and combined silica, mostly in the form of quartz sand. In the abysmal deposits far from land there is an average of only about 30 per cent. of silica, and hardly any of this in the form of quartz sand. Lime, iron, and the other bases largely predominate in these abysmal regions. The continuous loading on the margins of the emerged land by deposits tends by increased pressure to keep the materials of the tektosphere in a solid condition immediately beneath the loaded area. The unloading of emerged land tends by relief of pressure to produce a viscous condition of the tektosphere immediately beneath the denuded surfaces. Under the influence of the continuous shakings, tremors, and tremblings always taking place in the lithosphere the materials of the tektosphere yield to the stresses acting on them, and the deep-seated portions of the terrigenous deposits are slowly carried towards, over, or underneath the emerged land. The rocks subsequently re-formed beneath continental areas out of these terrigenous materials, under great pressure and in hydrothermal conditions, would be more acid than the rocks from which they were originally derived, and it is well known that the acid silicates have a lower specific gravity than the intermediate or basic ones. By a continual repetition of this process the continental protuberances have been gradually built up of lighter materials than the other parts of the lithosphere. The relatively light quartz, which is also the most refractory, the most stable, and the least fusible among rock-forming minerals, plays in all this the principal *rôle*. The average height of the surface of the continents is about three miles above the average level of the abysmal regions. If now we assume the average density of the crust beneath the continents to be 2.5, and of the part beneath the abysmal regions to be 3, then the spheroidal surface of equal pressure—the tektosphere—would have a minimum depth of eighteen miles beneath the continents and fifteen miles beneath the oceans, or if we assume the density of the crust beneath the continents to be 2.5, and beneath the abysmal regions to be 2.8, then the tektosphere would be twenty-eight miles beneath the continents and twenty-

five miles beneath the oceans. The present condition of the earth's crust might be brought about by the disintegration of a quantity of quartz-free volcanic rock, covering the continental areas to a depth of eighteen miles, and the re-formation of rocks out of the disintegrated materials.

When the lighter and more bulky substances have accumulated there has been a relative increase of volume, and in consequence bulging has taken place at the surface over the continental areas. Where the denser materials have been laid down there has been flattening, and in consequence a depression of the abysmal regions of the ocean-basins. It is known that, as a general rule, where large masses of sediment have been deposited, their deposition has been accompanied by a depression of the area. On the other hand, where broad mountain platforms have been subjected to extensive erosion, the loss of altitude by denudation has been made good by a rise of the platform. This points to a movement of matter on to the continental areas.

If this be anything like a true conception of the interactions that are taking place between the various geospheres of which our globe is made up, then we can understand why, in the gradual evolution of the surface features, the average level of the continental plains now stands permanently about three miles above the average level of those plains which form the floor of the deep ocean basins. We may also understand how the defect of mass under the continents and an excess of mass under the oceans have been brought about, as well as deficiency of mass under mountains and excess of mass under plains. Even the local anomalies indicated by the plumb-line, gravity, and magnetic observations may in this way receive a rational explanation. It has been urged that an enormous time —greater even than what is demanded by Darwin—would be necessary for an evolution of the existing surface features on these lines. I do not think so. Indeed, in all that relates to geological time I agree, generally speaking, with the physicists rather than with the biologists and geologists.

Progress of Oceanic Research.

I have now touched on some of the problems and speculations suggested by recent deep-sea explorations; and there are many others, equally attractive, to which no reference has been made. It is abundantly evident that, for the satisfactory explanation of many marine phenomena, further observations and explorations are necessary. Happily there is no sign that the interest in oceanographical work has in any way slackened. On the contrary, the number of scientific men and ships engaged in the study of the ocean is rapidly increasing. Among all civilized peoples and in all quarters of the globe the economic importance of many of the problems that await solution is clearly recognized.

We have every reason to be proud of the work continually carried on by the officers and ships attached to the Hydrographic Department of the British Navy. They have surveyed coasts in all parts of the world for the purposes of navigation, and within the past few years have greatly enlarged our knowledge of the sea-bed and deeper waters over wide stretches of the Pacific and other oceans. The samples of the bottom which are procured, being always carefully preserved by the officers, have enabled very definite notions to be formed as to the geographical and bathymetrical distribution of marine deposits.

The ships belonging to the various British Telegraph Cable Companies have done most excellent work in this as well as in other directions. Even during the present year Mr. R. E. Peake has in the s.s. *Brit-*

annia procured 477 deep soundings in the North Atlantic, besides a large collection of deep-sea deposits, and many deep-sea temperature and current observations.

The French have been extending the valuable work of the *Talisman* and *Travailleur*, while the Prince of Monaco is at the present moment carrying on his oceanic investigations in the Arctic Seas with a large new yacht elaborately and specially fitted out for such work. The Russians have recently been engaged in the scientific exploration of the Black Sea and the Caspian Sea, and a special ship is now employed in the investigation of the Arctic fisheries of the Murman coast under the direction of Professor Knipowitsch. Admiral Makaroff has this summer been hammering his way through Arctic ice, and at the same time carrying on a great variety of systematic observations and experiments on board the *Yermak*—the most powerful and most effective instrument of marine research ever constructed. Mr. Alexander Agassiz has this year recommenced his deep-sea explorations in the Pacific on board the U. S. steamer *Albatross*. He proposes to cross the Pacific in several directions, and to conduct investigations among the Paumotu and other coral island groups. Professor Weber is similarly employed on board a Dutch man-of-war in the East Indian Seas. The Deutsche Seewarte at Hamburg, under the direction of Dr. Neumayer, continues its praiseworthy assistance and encouragement to all investigators of the ocean, and this year the important German Deep-sea Expedition, in the s.s. *Valdivia*, arrived home after most successful oceanographical explorations in the Atlantic, Indian, and Great Southern Oceans.

The *Belgica* has returned to Europe safely with a wealth of geological and biological collections and physical observations, after spending, for the first time on record, a whole winter among the icefields and icebergs of the Antarctic. Mr. Borchgrevink in December last again penetrated to Cape Adare, successfully landed his party at that point, and is now wintering on the Antarctic continent. The expeditions of Lieutenant Peary, of Professor Nathorst, of Captain Sverdrup, and of the Duke of Abbruzzi, which are now in progress, may be expected to yield much new information about the condition of the Arctic Ocean. Mr. Wellman has just returned from the north of Franz Josef Land, with observations of considerable interest.

Some of the scientific results obtained by the expeditions in the Danish steamer *Ingolf* have lately been published, and these, along with the results of the joint work pursued for many years by the Swedes, Danes, and Norwegians, may ultimately have great economic value from their direct bearing on Fishery problems, and on weather forecasting over long periods of time.

Largely through the influence of Professor Otto Pettersson an International Conference assembled at Stockholm a few months ago, for the purpose of deliberating as to a programme of conjoint scientific work in the North Sea and northern parts of the Atlantic, with special reference to the economic aspect of sea-fisheries. A programme was successfully drawn up, and an organization suggested for carrying it into effect; these proposals are now under the consideration of the several States. The Norwegian Government has voted a large sum of money for building a special vessel to conduct marine investigations of the nature recommended by this conference. It is to be hoped the other North Sea Powers may soon follow this excellent example.

The various marine stations and laboratories for scientific research in all parts of the world furnish each year much new knowledge concerning the ocean. Among

our own people the excellent work carried on by the Marine Biological Association, the Irish Fisheries Department, the Scottish Fishery Board, the Lancashire Fisheries Committee, the Cape and Canadian Fisheries Department, is well worthy of recognition and continued support. Mr. George Murray, Mr. H. N. Dickson, Professor Cleve, Professor Otto Pettersson, Mr. Robert Irvine, and others have, with the assistance of the officers of the Mercantile Marine, accumulated in recent years a vast amount of information regarding the distribution of temperature and salinity, as well as of the planktonic organisms at the surface of the ocean. The papers by Mr. H. C. Russell on the icebergs and currents of the Great Southern Ocean, and of Mr. F. W. Walker on the density of the water in the Southern Hemisphere, show that the Australian colonies are taking a practical interest in oceanographical problems.

Proposed Antarctic Explorations.

The great event of the year, from a geographical point of view, is the progress that has been made towards the realization of a scheme for the thorough scientific exploration in the near future of the whole South Polar region. The British and German Governments have voted or guaranteed large sums of money to assist in promoting this object, and princely donations have likewise been received from private individuals, in this connection the action of Mr. L. W. Longstaff in making a gift of 25,000*l.*, and of Mr. A. C. Harmsworth in promising 5,000*l.*, being beyond all praise.

There is an earnest desire among the scientific men of Britain and Germany that there should be some sort of coöperation with regard to the scientific work of the two expeditions, and that these should both sail in 1901, so that the invaluable gain attaching to simultaneous observations may be secured. Beyond this nothing has, as yet, been definitely settled. The members of the Association will presently have an opportunity of expressing their opinions as to what should be attempted by the British Expedition, how the work in connection with it should be arranged, and how the various researches in view can best be carried to a successful issue.

I have long taken a deep interest in Antarctic exploration, because such exploration must necessarily deal largely with oceanographical problems, and also because I have had the privilege of studying the conditions of the ocean within both the Arctic and Antartic circles. In the year 1886 I published an article on the subject of Antarctic. Exploration in the 'Scottish Geographical Magazine.' This article led to an interesting interview, especially when viewed in the light of after events, for a few weeks after it appeared in type, a young Norwegian walked into the *Challenger* office in Edinburgh to ask when the proposed expedition would probably start, and if there were any chance of his services being accepted. His name was Nansen.

When at the request of the President I addressed the Royal Geographical Society on the same subject in the year 1893, I made the following statement as to what it seemed to me should be the general character of the proposed exploration: "A dash at the South Pole is not, however, what I advocate, nor do I believe *that* is what British Science at the present time desires. It demands rather a steady, continuous, laborious, and systematic exploration of the whole southern region with all the appliances of the modern investigator." At the same time I urged further, that these explorations should be undertaken by the Royal Navy in two ships, and that the work should extend over two winters and three summers.

This scheme must now be abandoned, so far at least as the Royal Navy is concerned, for the Government has intimated that it

can spare neither ships nor officers, men nor money, for an undertaking of such magnitude. The example of Foreign Powers—rather than the representations from our own scientific men—appears to have been chiefly instrumental in at last inducing the Government to promise a sum of 45,000*l.*, provided that an equal amount be forthcoming from other sources. This resolve throws the responsibility for the financial administration, for the equipment, and for the management of this exploration, on the representative scientific societies, which have no organization ready for carrying out important executive work on such an extensive scale. I am doubtful whether this state of matters should be regarded as a sign of increasing lukewarmness on the part of the Government towards marine research, or should rather be looked on as a most unexpected and welcome recognition of the growing importance of science and scientific men to the affairs of the nation. Let us adopt the latter view, and accept the heavy responsibility attached thereto.

Any one who will take the trouble to read, in the 'Proceedings' of the Royal Society of London, the account of the discussion which recently took place on 'The Scientific Advantages of an Antarctic Expedition,' will gather some idea of the number and wide range of the subjects which it is urged should be investigated within the Antarctic area; the proposed researches have to do with almost every branch of science. Unless an earnest attempt be made to approach very near to the ideal there sketched out, widespread and lasting disappointment will certainly be felt among the scientific men of this country. The proposed expedition should not be one of adventure. Not a rapid invasion and a sudden retreat, with tales of hardships and risks, but a scientific occupation of the unknown area by observation and experiment should be aimed at in these days.

I have all along estimated the cost of a well-equipped Antarctic Expedition at about 150,000*l.* I see no reason for changing my views on this point at the present time, nor on the general scope of the work to be undertaken by the proposed expedition, as set forth in the papers I have published on the subject. There is now a sum of at most 90,000*l.* in hand, or in view. If one ship should be specially built for penetrating the icy region, and be sent south with one naturalist on board, then such an expedition may, it will be granted, bring back interesting and important results. But it must be distinctly understood that this is not the kind of exploration scientific men have been urging on the British public for the past fifteen or twenty years. We must, if possible, have two ships, with landing parties for stations on shore, and with a recognized scientific leader and staff on board of each ship. Although we cannot have the Royal Navy, these ships can be most efficiently officered and manned from the Mercantile Marine. With only one ship many of the proposed observations would have to be cut out of the program. In anticipation of this being the case, there are at the present moment irreconcilable differences of opinion among those most interested in these explorations, as to which sciences must be sacrificed.

The difficulties which at present surround this undertaking are fundamentally those of money. These difficulties would at once disappear and others would certainly be overcome, should the members of the British Association at this meeting agree to place in the hands of their president a sum of 50,000*l.*, so that the total amount available for Antarctic exploration would become something like 150,000*l.* Although there is but one central Government, surely there are within the bounds of this great Empire two more men like Mr. Longstaff. The Government has suddenly placed the

burden of upholding the high traditions of Great Britain in marine research and exploration on the shoulders of her scientific men. In their name I appeal to all our well-to-do fellow-countrymen in every walk of life for assistance, so that these new duties may be discharged in a manner worthy of the Empire and of the well-earned reputation of British Science.

JOHN MURRAY.

RECENT PROGRESS IN OCEANOGRAPHY.

UNDER the title 'On the Laws of Movement of Sea-Currents and Rivers,' Dr. A. W. Cronander, of the Technical School at Noorköping, Sweden, has recently published a volume, giving the results of researches based upon his observations of

currents at different depths, taken in 1875–1877 from the lightships in the Baltic, the Great Belt and the Sound. Similar observations on the rivers Göta Elf and Motala Ström in Sweden, in the years 1893–1895, are also utilized together with the regular daily observations of winds and surface currents, recorded on the lightships in the Baltic and in the passages leading thence to the North Sea.

These results are certainly very interesting as they establish the fact that the currents in the Baltic obey the winds and that none of the other causes, to which we are accustomed to attribute motions in sea water, such as differences in density and temperature, and affluence of rivers, produce any currents which are either distinctive or perceptible.

Under the assumption that Dr. Cronander's investigations are not readily accessible to many of those interested in these matters, I propose, with his approbation, to furnish a short résumé to this journal.

Dr. Cronander takes up the question of the existence of a current from the Baltic into the North Sea, on account of difference of level. This difference has been determined by precise leveling, between the Bothnian Gulf, near Sundwall, and Levanger, near the Frith of Trondhjem, and is 0.725 m. On account of the difference in specific gravity, which is assumed at 1.027 in the North Sea, and 1.003 in the Bothnian Sea, the difference of level has been calculated to be 0.546 m. This would give a fall of the Baltic current of 1 to more than 3,000,000, and since it has been demonstrated that with an inclination of 1 : 500,000 the motion of water is hardly perceptible, it is concluded that difference of level between the Baltic and North seas cannot produce any appreciable currents.

But it has been tacitly assumed that in consequence of the great quantities of fresh water which are constantly precipitated into the Baltic by some 250 rivers (among them five of the larger ones in Europe), there must exist a surface current, the so-called *Baltic Current*, by which this excess of water is carried off into the North Sea.

Dr. Cronander finds two alternate currents in the passages leading to the North Sea, which are controlled solely by the

winds. With easterly winds (N. N. E., to S. S. E.), the water flows into the North Sea through all these channels, and with westerly winds (N. N. W., to W. S. W.), the current reverses from the North Sea into the Baltic. The difference between the quantity of water which, within a specified time, is carried out of the Baltic and into it, indicates the quantity which has been definitely removed from the Baltic within the time, and furnishes an indication of the force of the Baltic current; hence the current has no specific existence but only a differential one.

Assuming t to be the time during a year when outgoing currents prevail, and v the mean velocity, likewise t' the length of time for inflowing currents during the period, and v' their mean velocity, the mean velocity of the Baltic current will be given by the formula

$$V = \frac{vt - v't'}{t + t'}.$$

Dr. Cronander has calculated this velocity for the sound for two decades, 1850–59 and 1864–73, and obtained for the first period $v = 1.204$, $v' = 1.304$ and $V = 0.257$ and for the second period $v = 1.153$, $v' = 1.230$ and $V = 0.210$ (velocities in knots per hour). It will be noticed that the mean current from the North Sea is stronger than that from the Baltic, and since, in spite of this, more water is conveyed from the Baltic than into it, the outgoing current must be of greater duration. Similar calculations have also been made for the Great Belt, but only for the term of a few years; they show that in some years more water flows through this passage *into* the Baltic than *out* of it. These measures of velocity apply to the surface only, and now the important question comes up, to what depth is the current propagated and what is the law of decrease with increasing depth?

Currents which are caused directly by the winds, denominated '*drift currents*,' show a very rapid decrease of velocity with increase of depth in consequence of friction, as indicated in the adjoining diagram (A); in rivers, where the velocity is due to the difference of level, the decrease of velocity with the depth is very gradual as shown by the accompanying diagram (B). The difference in the shape of these diagrams is so apparent that nobody can make a mistake in deciding whether a given current belongs to one or the other of the two classes.

Now Dr. Cronander found that wherever he measured the currents under the surface, whether in the Baltic, the Sound, the Belt, or the Cattegat, the observations always pointed to differences of level as the cause, and against a supposition of a direct effect of the winds. This is then another important conclusion which Dr. Cronander reached, viz.: that although the currents of the Baltic appear to obey the winds, the winds are not the immediate cause, but the difference of level created by preceding winds. To illustrate: Supposing a strong westerly wind to have been blowing over the Baltic, it will produce an accumulation of water in the eastern and northern part, and a corresponding depression of level in the western part. As soon as these westerly winds are replaced by easterly ones, the pent up waters will flow in an easterly direction, more in consequence of reaction against the preceding westerly winds, than in obedience to existing easterly winds. It must be observed that the greatest velocities were not generally found at the surface. Thus, in the Sound the average velocity of the outgoing current, 3.55 decimeters per second, was found at the surface; that of the ingoing current, 3.66 decimeters at the depth of 1 fathom. For the Great Belt, the corresponding figures were 3.81 decimeters at 4 fathoms for the outgoing, and 3.78 at 6 fathoms for the ingoing current. The shift of greatest velocity from a surface to a

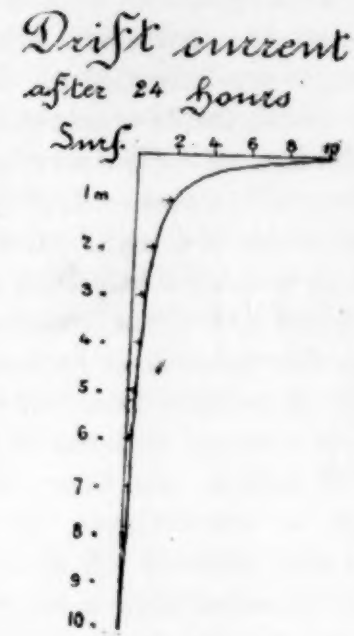
lower plane is satisfactorily explained by the interference of local winds with the direction of the surface currents.

The existence of a heavier layer of salt water in the deeper part of the Baltic has been generally attributed to the existence of an undercurrent from the North Sea into the Baltic. Dr. Cronander found no traces of such an undercurrent in the shallow part of the Sound, where, at 5 fathoms depth, the ingoing and the outgoing currents each reached to the bottom. He compares the movement of the water here to that of two wedges, one of fresh water at the surface which has its base in the Baltic, and superposed upon one of salt water which has its base in the North Sea; both wedges are driven as a whole backward and forward by the currents, with the effect that sometimes the whole Sound is nearly filled with fresh water and at other times with salt water.

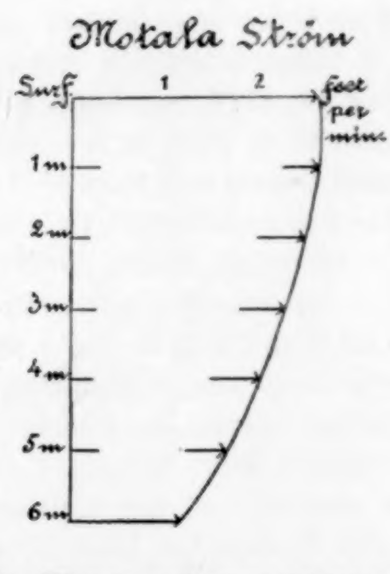
In the Great Belt the conditions were found to be somewhat different. With strong easterly or westerly winds, the outgoing or ingoing currents reach to the bottom, but sometimes the brackish water from the Baltic combines with the salt water from the North Sea in the shallow part of the Belt, and constitutes a homogeneous water-mass which is moved forward and backward. Again, sometimes a distinct bottom current is formed which moves in an opposite direction to the surface current. With low water in the Baltic, and an outgoing surface current, an ingoing bottom current may arise; and with high water in the Baltic, and ingoing surface current, an outgoing undercurrent may be called into existence.

From these statements we conclude that the assumed undercurrent from the North Sea into the Baltic does not present the normal condition, but that undercurrents into and out of the Baltic may occasionally be called into existence in the Great Belt by an effort of water at the bottom, to restore the hydrostatic equilibrium when it has been disturbed at the surface, and such a restoration at the surface is prevented by

A



B



the winds. Hence, we may assume that the greater part of the salt water, which we find at the bottom of the Baltic, finds its way into it by surface currents, and that by reason of its weight and loss of heat by contact with the colder water, it settles to the bottom.

In the northern Baltic, two alternating sets of currents were found; an outgoing one, coming from a N. N. E. direction with

a mean velocity of 1.06 decimeters per second at the surface, and 0.20 decimeter at the bottom in 55 m. depth, and an ingoing current from S. W., to W. S. W. with 2.16 decimeters velocity at the surface and 0.37 decimeter at the bottom. With strong winds the currents extended all the way to the bottom; with feeble winds still water is found at the bottom. Contrary local winds often produce still water or drift currents at the surface, when the main current is outgoing, but the stronger inflowing current is seldom stopped by contrary winds.

The salt determinations in the northern Baltic show a surface layer of 15–20 m. deep with an average saltness of 5.6 to 5.7 grammes of salt to the liter; between 20 and 45 m. a mixed layer of 6 to 7.3 grammes; and between 45 and 55 m. a nearly homogeneous bottom layer of 7.5 to 7.7 grammes of salt, which shows scarcely any variation during different seasons. This bottom layer also shows but slight changes of temperature; between June 11 and August 16, 1877, the temperature rose from 0°.5 to 1°.6, while at the surface during the same time it rose from 4°.6 to 17°.5.

Thus far I have followed Dr. Cronander, but I feel tempted, before concluding, to make a few remarks concerning the conclusions reached, and also to apply the results obtained towards the explanation of some of the more prominent ocean currents, which he has refrained from doing.

In the estimate of the Baltic current, based on difference of level between the Baltic and North Sea, a uniform slope of 1: 3000000 from the head of the Baltic to the North Sea has been assumed. It appears quite probable to me that, on account of the obstruction which the narrow and shallow passages interpose to the free passage of water between these two seas, the surface of the Baltic will be nearly on a perfect level and that at its juncture with the North Sea there will be a much greater difference of level than that indicated by a slope of 1: 3000000 and quite sufficient to produce perceptible currents in the Sound and Great Belt. In a critical examination of the currents in these two passages, I think the tidal currents should have received some consideration. The rise of the tide in different parts of the Baltic furnishes the means of determining the strength of these currents; and, however small it may be, the figures should have been produced just as has been done with the so-called Baltic Current. Furthermore, I am willing to admit that Dr. Cronander's observations prove that in the open Baltic the currents move in obedience to laws identical with those governing the flow of rivers; but in the Sound and Great Belt the direction and flow of currents are so greatly modified by contraction of the channels, that a current, which in the open Baltic or North Sea might be considered a mere drift current, could be easily changed into a veritable river current.

The equatorial currents appear to me to be fair examples of surface currents which derive their strength solely from the action of the trade winds. Unfortunately, deep-sea current observations are not at hand, but, if the above supposition holds, their depth cannot be very great. The current through the Strait of Yucatan, which at the surface surpasses the strength of all the Gulf Stream waters, is assumed to be due to the partial barrier, namely, Yucatan and Cuba, between the Caribbean Sea and the Gulf of Mexico. According to Pillsbury's observations, I estimate its depth at 200 fathoms. The undercurrent from the Gulf of Mexico, which I am led to believe exists, from comparison of the quantities of water that enter the Gulf and leave it through the Strait of Florida, may possibly be explained upon the same grounds as those undercurrents occasionally met with in the Great Belt, viz., an effort towards the restoration of

equilibrium, disturbed at the surface by the effect of the winds. The conditions are nearly identical. In the Baltic, easterly winds and currents force the waters into the North Sea, raise the level of the Great Belt, and give rise to an undercurrent from the North Sea into the Baltic. Here we assume that the waters, which the equatorial currents succeed in piling up in the western part of the Caribbean Sea, seek a passage through the Yucatan Strait into the Gulf of Mexico; that in this passage the level stands higher than on either side, and that the water forced into the Gulf of Mexico raises its level over that of the eastern portion of the Caribbean Sea. Since equilibrium cannot be restored at the surface, it is done by an undercurrent from the Gulf. Somewhat different from these conditions are those which are supposed to govern the flow of the Gulf Stream from the Gulf of Mexico into the Atlantic. Pillsbury's current observations in the Strait of Florida show that in the narrow parts the current touches bottom. There remains little doubt at present that the Gulf Stream owes its origin to the difference of level between the Gulf of Mexico and the Atlantic. Recent precise leveling, by the Coast and Geodetic Survey, indicates that between the mean level of the ocean at St. Augustine, on the eastern coast of Florida, and that of the Gulf at Cedar Keys, on the western, there exists a difference of nine-tenths of a foot. Some surprise might be expressed that such an insignificant difference should be able to set such a powerful stream into motion. But if we assume the Gulf to represent a basin, and the Strait of Florida a narrow orifice by which it communicates with the Ocean and apply Torricelli's theorem, neglecting friction, we obtain the velocity of $v = \sqrt{2g \times 0.9} = 7.6$ feet per second, which is not very greatly in excess of the average velocity of the Gulf Stream in the most contracted portion of the Strait.

Some authors speak of the impulse of the Gulf Stream carrying its waters against the western coast of Europe, and producing a higher level there than exists on the eastern coast of North America. Whatever impulse the Gulf Stream possesses is due to its higher level, and I cannot comprehend how such an impulse can make it ascend an inclined plane. What is meant, I presume, is the Gulf Stream drift, the motive power of which is the prevailing westerly winds of the North Atlantic. It is generally supposed that this Gulf Stream drift is compensated for by an undercurrent setting from the western shores of Europe in a southwesterly direction.

A. LINDENKOHL.

OBSERVATIONS ON RHYTHMIC ACTION.

Two entirely different forms of regularly repeated action are to be distinguished. In one form the subject is left free to repeat the movement at any interval he may choose. This includes such activities as walking, running, rowing, beating time, and so on. A typical experiment is performed by taking the lever of a Marey tambour between thumb and index finger and moving the arm repeatedly up and down; the recording tambour writes on the drum the curve of movement. Another experiment consists in having the subject tap on a telegraph key or on a noiseless key and recording the time on the drum by sparks or markers. Other experiments may be made with an orchestra leader's baton having a contact at the extreme end, with a heel contact on a shoe, with dumb-bells in an electric circuit, and so on. For this form of action I have been able to devise no better name than 'free rhythmic action.'

In contrast with this there is what may be called 'regulated rhythmic action.' This is found in such activities as marching in time to drum-beats, dancing to music, playing in time to a metronome, and so on. A

typical experiment is that of tapping on a key in time to a sounder-click, the movement of the click and that of the movement of the finger being registered on a drum.

Regulated rhythmic action differs from free rhythmic action mainly in a judgment on the part of the subject concerning the coincidence of his movements with the sound heard (or light seen, etc.). This statement, if true, at once brushes aside all physiological theories of regulated rhythmic action. One of these theories is based on the assumption (Ewald) that the labyrinth of the ear contains the tonus-organ for the muscles of the body. It asserts that vibrations arriving in the internal ear affect the whole contents including the organ for the perception of sound and the tonus-organ. Thus, sudden sounds like drum-beats or emphasized notes would stimulate the tonus-organ in unison, whereby corresponding impulses would be sent to the muscles. This theory has very much in its favor. It is undoubtedly true that such impulses are sent to the muscles. Thus at every loud stroke of a pencil on the desk I can feel a resulting contraction in the ear which I am inclined to attribute to the *M. tensor tympani*. Likewise a series of drum-beats or the emphasized tones in martial or dance music seem to produce twitchings in the legs. Féré has observed that, in the case of a hysterical person exerting the maximum pressure on a dynamometer, the strokes of a gong are regularly followed by sudden increased exertions. Nevertheless, these twitchings are not the origin of the movements in regulated rhythmic action. For many years I have observed that most persons regularly beat time just before the signal occurs; that is, the act is executed before the sound is produced. Records of such persons have been published (*e. g.*, New Psychology, p. 182), but their application to the invalidation of the tonus-theory was first suggested by Mr. Ishiro Miyake. This does not exclude the use of muscle sensations, derived from tonus-twitches, in correcting movements in regulated rhythmic action, although they presumably play a small or negligible part as compared with sounds.

Another argument in favor of the subjective nature of regulated rhythmic action is found in the beginning of each experiment on a rhythm of a new period; the subject is quite at loss for a few beats and can tap only spasmodically until he obtains a subjective judgment of the period. If the tonus-theory were correct, he should tap just as regularly at the start as afterward.

The conclusion seems justified that regulated rhythmic action is a modified free rhythmic action, whereby the subject repeats an act at what he considers regular intervals, and constantly changes these intervals to coincide with objective sounds which he accepts as objectively regular.

In free rhythmic action there is one interval which on a given occasion is easiest of execution by the subject. This interval is continually changing with practice, fatigue, time of day, general health, external conditions of resistance, and so on.

"It has long been known that in such rhythmic movements as walking, running, etc., a certain frequency in the repetition of the movement is most favorable to the accomplishment of the most work. Thus, to go to the greatest distance in steady traveling day by day the horse or the bicyclist must move his limbs with a certain frequency; not too fast, otherwise fatigue cuts short the journey, and not too slow, otherwise the journey is made unnecessarily short. This frequency is a particular one for each individual and for each condition in which he is found. Any deviation from this particular frequency diminishes the final result."

It is also a well-known fact that one rate of work in nearly every line is peculiar to

each person for each occasion, and that each person has his peculiar range within which he varies. Too short or too long a period between movements is more tiring than the natural one in walking, running, rowing, bicycling, and so on.

It is highly desirable to get some definite measurement of the difficulty of a free rhythmical action. This cannot well be done by any of the methods applicable to the force or quickness of act, but it may be accomplished in the following manner:

As a measure of the irregularity in a voluntary act we may use the probable error. When a series of measureable acts are performed they will differ from one another, if the unit of measurement is fine enough. Thus, let x_1, x_2, $\cdots$, x_n be successive intervals of time marked off by a subject beating time, or walking, or running, at the rate he instinctively takes. The average of the measurements,

$$a = \frac{x_1 + x_2 + \cdots + x_n}{n},$$

can be considered to give the period of natural rhythm under the circumstances. The amount of irregularity in the measurements is to be computed according to the well-known formula:

$$p = \sqrt{\frac{v_1^2 + v_1^2 + \cdots + v_n}{n-1}}$$

where $v_1 = x_1 - a$, $v_2 = x_2 - a$, $\cdots$, $v_n = x_n - a$. The quantity p is known as the 'probable error,' or the 'probable deviation.' The quantity

$$r = \frac{p}{a},$$

the 'relative probable error,' expresses the probable error as a fraction of the average.

If all errors in the apparatus and the external surroundings have been made negligible, this 'probable error' is a personal quantity, a characteristic of the irregularity of the subject in action. If, as may be readily done, the fluctuations in the action of the limbs of the subject be reduced to a negligible amount, this probable error becomes a central, or subjective, or psychological, quantity. Strange as it may appear, psychologists have never understood the nature and the possibilities of the probable error (or of the related quantities, 'average deviation,' 'mean error,' etc.). In psychological measurements it is—when external sources of fluctuation are rendered negligible—an expression for the irregularity of the subject's mental processes. Nervous or excitable people invariably have large relative probable errors; phlegmatic people have small ones.

Thus a person with a probable error of 25% in simple reaction time will invariably have a large error in tapping on a telegraph key, in squeezing a dynamometer, and so on. I have repeatedly verified this in groups of students passing through a series of exercises in psychological measurements. I do not believe it going too far to use the probable error as a *measure* of a person's irregularity. This is equivalent to asserting that a person with a probable error twice as large as another's is twice as irregular, or that if a person's probable error in beating time at one interval is r_1 and at another interval r_2, his irregularity is r_1 times as great in the second case as in the first. This concept is analogous to that of precision in measurements. We might use the reciprocal of the probable error as a measure of regularity. The positive concept, however, is in most minds the deviation, variation or irregularity, and not the lack of deviation, the non-variability, or the regularity. In the case of the word 'irregularity' the negative word is applied to a concept that is naturally positive in the average mind.

The irregularity in an act is a good expression of its difficulty. Thus, if a person beating time at the interval T has an ir-

regularity measured by the probable error P and at the interval t a probable error p, it seems justifiable to say that the interval t is $\frac{p}{P}$ times as difficult as T. If T is the natural interval selected by the subject, then the artificial interval t would be more difficult than T, and we should measure the difficulty by comparing probable errors.

It is now possible to state with some definiteness the law of difficulty for free rhythmic action. Let T be the natural period and let its probable error—that is, its difficulty—be P. It has already been observed (SCIENCE, 1896, N. S., IV., 535), that any other larger or smaller period (slower or faster beating) will be more difficult than the natural one and will have a larger probable error. Thus any interval t will have a probable error p which is greater than P, regardless of whether t is larger or smaller than T.

Three years ago (SCIENCE, as above) I promised a complete expression for this law. Continued observations during this time enable me to give an idea of its general form. The results observed can be fairly well expressed by the law

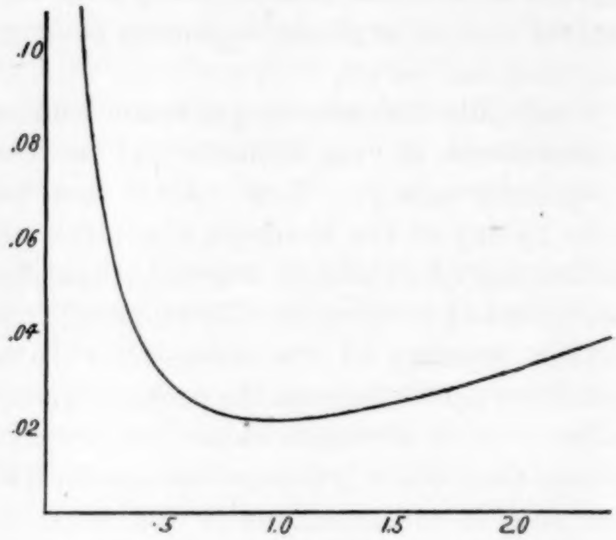
$$p = P\left(1 + c\,\frac{[t - T]^2}{t}\right)$$

in which T is the natural period, P the probable error for T, t any arbitrary period, p the probable error for t and c a personal constant.

This may be called the law of difficulty in free rhythmic action. A curve expressing the equation for $T = 1.0^s$, $P = 0.02^s$ and $c = 1$ is given in the figure.

It will be noticed that periods differing but little from the natural one are not much more difficult and that the difficulty increases more rapidly for smaller than for larger periods.

In plotting this curve I have assumed unity as the value for all personal constants. The personal constants will undoubtedly vary for different persons, for different occasions and for different forms



of action; an investigation is now in progress with the object of determining some of them.

In case it is desired to know what periods are of a difficulty 2, 3, ⋯, n times that of T, a table of values for p may be drawn up in the usual way and that value for t sought for (with interpolation) which gives for p a value 2, 3, ⋯, n times as great. Thus, in a table for the above example it is found that the periods 0.38^s and 2.6^s are twice as difficult.

This law can be stated in another form which is of special interest to the psychologist. To the person beating-time a period of 0 is just as far removed from his natural period as one of ∞ ; both are infinitely impossible. The objective scale does not express this fact; objectively a period of 0 is as different from a period of 1^s as a period of 2^s would be. Similar considerations hold good for the lesser periods; the scale by which the mind estimates periods is different from their objective scale. This difference may be expressed by asserting that the following relations exist between the two :

$$x = c\,\frac{(t - T)^2}{t}$$

where x is the measure on the mental scale, T the natural period, t any other period, and c a personal constant. By this formula the various periods may be laid off according to their mental differences from the natural period. Every difference from the natural period is mentally a positive matter. With the mental scale the law of difficulty becomes

$$p = P(1 + cx)$$

where p and P are the probable errors for t and T respectively, x is the measure on the mental scale and c is a personal constant. This is the equation of a straight line. The law states that the difficulty of any arbitrary period is directly proportional to its mental difference from the natural period. This is the statement which I tried to make in the note published in SCIENCE, 1896, N. S., IV., 535.

This law of difficulty as depending on the period is, of course, only one of the laws of free rhythmic action. It is quite desirable that other laws of difficulty and of frequency should be determined. For example, observations on ergograph experiments tend to show that the irregularity and the natural period both change with the weight moved; they also change with the extent of the movement.

Such a series of well established laws might be useful in regulating various activities to the best advantage. It is already recognized that it is most profitable to allow soldiers on the march to step in their natural periods; it is also known that on the contrary sudden and tense exertion is favored by changing the free rhythmic action into regulated action by marching in step and to music. More definite knowledge might perhaps be gained concerning the most profitable adjustments of the rhythm and extent of movement in bicycle-riding to the person's natural period; at present only average relations are followed in the adjustment of crank-length, gear and weight to bicycle-riders, individual and sex differences not being fully compensated. Other examples will suggest themselves.

Not only does every simple activity have its own natural rhythms; combinations of activities have rhythms that are derived from the simpler ones. In fact, it may be said that the individual, as a totality, is subjected to a series of large rhythms for his general activity (*e. g.*, yearly, monthly, weekly, daily, and so on), and also to a series of smaller rhythms for his special activities. The natural periods do not always correspond with the enforced periods. The daily rhythm is unquestionably too slow for some persons and too rapid for others; the unavoidable enforcement of the 24-hour period works a loss to all who would naturally vary from it, and diminishes the total amount of work that could be produced by them. For large numbers of brain-workers the 24-hour period is too long; for many of them the natural period is probably about 18 hours. Although about one-quarter of the day is not efficiently used, there is little relief in splitting up the day into parts, because (1) the 12-hour period would be naturally even less advantageous than the 24-hour one, and (2) the rhythm of the environment cannot be made to fit.

The progress of civilization and the changes in life are undoubtedly tending to shorten the natural period from 24 hours by encouraging a greater discharge of energy at shorter intervals. Since the 24-hour rhythm is a fixed one, there must be a constant effort at adjustment in this respect by those individuals most susceptible to the new influences. The survival of the fittest will, of course, tend to keep the natural rhythm not far from the 24-hour period.

E. W. SCRIPTURE.

PSYCHOLOGICAL LABORATORY,
YALE UNIVERSITY,
August 1, 1899.

GEOLOGY AT THE BRITISH ASSOCIATION.

The address of the President of the Section, Sir Archibald Geikie, already published in this Journal was conspicuous for the definiteness of its reliance on geological evidence as opposed to that derived from physical principles. He claimed, it will be remembered, that the importance of this evidence had never been weighed or appreciated by Lord Kelvin, while not a few physicists, including Darwin and Perry, are not in agreement with Lord Kelvin as to the extreme limitations imposed by his more recent estimate. It is interesting to note that almost simultaneously with the British Association meeting, there was published by the Royal Dublin Society a paper by Professor Joly in which he calculates that if the sodium in the sea and preserved in beds of rock salt were all derived by denudation from rocks in the earth-crust, at the present known rate of transport by rivers, from 80,000,000 to 90,000,000 years would have been necessary for its accumulation.

On account of the visit of the French and Belgium Geologists the President's address was not given till Saturday. The proceedings of the Section were therefore opened by papers on the South Eastern Coalfield, an account of which has already appeared in the columns of Science. Germane to this subject was a short note by Mr. Jukes-Browne on a boring through the Chalk and Gault near Dieppe. Beneath the sandy base of the Gault clay the waterbearing lower greensand was met with, and the section proved that the Folkestone and Wissant facies of the Gault extended for 52 miles southward.

No papers on the more ancient rock systems were read during the meeting, the earliest rocks dealt with being the carboniferous. Mr. Gibson's recent work in the North Staffordshire Coalfield is interesting not only because his important economic results flow chiefly from work in rocks of no economic value, but because it shows that detailed scientific work may reveal facts of important economic value even in a region pierced in every direction by mine shafts and worked continuously for centuries. For many coming years in Britain most vital facts, from a commercial point of view, with regard to the distribution of coal and iron, will be gradually accumulated by borings and sinkings through the neozoic rocks. Unless a systematic record of these borings is kept at a central bureau, their value to the nation will be lost and work will have to be done over again by private individuals, at a cost of millions. Much of this might be saved if observations are accumulated as they are obtained so as to give a good idea of the sub-triassic structure of the whole country.

Mr. Greenly exhibited photographs of funnel-shaped 'pipes' bored through the carboniferous limestone of Anglesey and filled with deposits of sandstone continuous with the beds above. The report of Mr. Garwood on the zoning of the British carboniferous rocks shows that though the difficulties surrounding this subject are lessening they have not yet been cleared away. Most of the zone fossils hitherto employed are not capable of more than restricted local use.

Mr. Wedd finds that in places the Bunter sandstone is cemented with barium sulphate, a fact frequently noted in the basal beds of the Keuper sandstones. Professor Watts described and showed photographs of the surface of the granite under the Keuper marls of Leicestershire. This possessed many of the features of wind eroded rocks, and one piece of granite exhibited was grooved and polished and presented an appearance recognized by many geologists present as characteristic of Æolian action.

The following new classification of the Pliocene deposits of the east of England was proposed by Mr. F. W. Harmer; Older Plio-

cene including the Lenhamian (Lenham Beds); newer Pliocene including Gedgravian (Coralline Crag); Waltonian (Walton and Oakley horizons); Newbournian, Butleyan, Icenian (Norwich Crag); Chillesfordian and Weybournian (Weybourne Crag and Forest Bed Series). The same author pointed out that shell accumulations comparable to the 'crags' are now only found on shores, such as Holland, open to prevalent southwesterly gales. He suggests that in Pliocene times Scandinavia may have been anticyclonic, diverting the winds in eastern England so that easterly gales were common. He further suggests that during the Glacial Epoch the ice-sheet of northern Europe might have been an anticyclonic center like Greenland at the present day. Evidence in favor of ice-sheet action in Anglesey was furnished in a paper by Mr. Greenly and Mr. Kendall reported on Erratic Blocks, dealing chiefly with Scandinavian and Cheviot boulders in Yorkshire. Mr. Lomas proposed to restrict the term 'moraine' to stationary deposits and the word 'rock-train' to *débris* riding on or moving with the ice.

The investigations carried on by a committee, of which Sir William Dawson is chairman and Professor Coleman secretary, succeeded in demonstrating, after meeting with many difficulties, that the warm climate beds of the Don Valley in Canada underlie the cold climate beds of Scarborough and that both series, underlain and covered by boulder clays, were interglacial in age. The fossil leaves and wood will be determined in time for the final report next year.

The committee on Irish elk remains in the Isle of Man has not as yet succeeded in its principal task. The committee on the Ty Newydd Caves in North Wales presented their final report in which they correlated the successive deposits with those of the Ffynnon Benno Caves, studied by Dr. Hicks, and concluded that the deposits in them were earlier than the boulder-clay of the district with northern and western erratics.

The exhibition of specimens of Eolithic and Paleolithic flints, including one obtained by Dr. Kerr from Folkestone, led to a brisk discussion on the antiquity of man, in which Sir John Evans, one of the first Englishmen to study the gravels of the Somme with Boucher de Perthes, declined to admit that the so-called Eolithic implements furnished any evidence of the existence of pre-Paleolithic man. This opinion he reiterated in a short paper read in the Boulogne Museum on the occasion of the visit of the Association to that town at the end of the meeting.

Amongst the paleontological papers may be mentioned Professor Rupert Jones' report on Paleozoic Phyllopoda, and an interesting exhibition by Dr. Rowe of slides, showing recent developments of photo-micrography of opaque objects as applied to the delineation of the minute structure of fossils. Professor Sollas initiated a discussion on homotaxy and contemporaneity, in which he concluded that the geological clocks in different localities were, figuratively speaking, never more than minutes and seldom more than seconds wrong.

Professor Renard announced that by subjecting quartzite, enveloped in an alloy, to hydrostatic pressure equal to 5,000 atmospheres, he had produced granulation in the quartz identical with that seen in silicate meteorites. Professor Sollas was able to bring positive proof of the existence of abundant sponge spicules in the chalk which are now represented by hollow casts to the extent of sometimes 3 per cent. of the rock.

Some beautiful examples of wave photographs were shown by Mr. Vaughan Jennings, including waves in rock, lava, mud, sand, soil-terraces and sand dunes. Dr. Tempest Anderson exhibited photographs

of the eruption of Vesuvius in 1898, and read a note by Professor Plalania on the recent eruption of Etna.

An interesting investigation, initiated by Professor Kendall and others, is being carried on to ascertain the course of the underground waters in the Craveri (Carboniferous Limestone) district of Yorkshire. Common salt, salts of ammonia, and fluorescin were placed in quantity in the 'sinks' and the water issuing miles away was periodically analyzed with the result of tracking the course of several underground drainage systems.

The Geological Photograph Committee exhibited a large series of prints and gave an account of the year's collection. It was resolved to publish a representative series of geological photographs if sufficient support was guaranteed to make the scheme self-supporting.

W. W. Watts.

SCIENTIFIC BOOKS.

The Mysterious Mammal of Patagonia, Grypotherium Domesticum. By Rudolph Hauthal, Santiago Roth and Robert Lehmann Nitsche. Revista del Museo de La Plata. Vol. IX. Pp. 409–474.

Under the above title the authors have issued a series of papers containing 65 pages of text and accompanied by five plates; dealing principally with that curious mammal to which Dr. Ameghino some two years ago gave the name of Neomylodon Listai.

Ameghino based his generic and specific descriptions upon a few small endermal ossicles and certain stories or traditions said to be current among the Indians of Patagonia concerning the existence of such an animal, and upon verbal descriptions of a piece of skin presumably belonging to a large gravigrade edentate. This piece of skin was found in a dessicated condition by Dr. Otto Nordenskjöld and Mr. Hermann Eberhard in a cavern near Consuelo Cove, in Last Hope Inlet, on the west coast of southern Patagonia.

Dr. Ameghino's announcement aroused great interest and has been frequently noted, both in scientific and popular journals, chiefly on account of the opinion advanced by him that this great sloth still exists in the interior of Patagonia and at present causes extreme terror among the Indians by its intensely predaceous habits!

During the past season Dr. Hauthal visited the cave from which the first piece of skin was obtained by Dr. Nordeskjöld and was successful in securing other pieces of skin associated with many bones and parts of skulls, showing the complete dentition. Associated with these remains he also found bones of other animals, principally belonging to the following genera: *Homo, Felis, Canis, Equus, Onohippidium, Auchenia, Mephitis, Rhea,* etc., together with stone and bone implements, mingled with charcoal and charred fragments of bones.

Dr. Hauthal gives a description of the cave with a diagram, showing where the more important finds were made. He also mentions several other unexplored caves in the same neighborhood.

Dr. Roth gives a classification and description of the different mammalian remains found, and reaches the conclusion that the sloth to which the skin, described at second hand by Ameghino belonged, does not represent a new genus. This is shown by a study of the skulls, teeth and other parts of the skeleton, found associated with pieces of skin, and which, according to Roth are not generically distinguishable from Grypotherium of Reinhardt, from the Pampean beds further north.

Dr. Roth places little reliance on the tales purporting to come from the Indians regarding the terrible animal frequenting regions adjacent to the larger lakes and rivers of the interior and which are said to attack and carry off their horses. He believes that at most this is only a tradition among them of the former existence of a very large cat, a few remains of which were found in the cave, and which though at present extinct may have existed contemporaneously with the present Indians of Patagonia several generations ago.

The habits attributed to this terrible animal, according to Ameghino by the Indians, are certainly more like those we should expect to find

among the larger members of the Felidæ than among the slow moving, inoffensive and herbivorous Edentates. Consequently if there be any truth whatever in these tales or traditions they probably refer to this large cat. Dr. Roth has referred these cat remains to Ameghino's species, retaining the specific name of Listai proposed by Ameghino. He rejects the generic name of Neomylodon, which would then clearly be a misnomer and substitutes the Indian name of Iemisch by which, according to Ameghino, the animal is known among the Indians. Two objections may be offered to this generic name, first its barbarous origin, which though not absolutely prohibited by rules governing the formation of such names should nevertheless be discouraged, and second, the material upon which it is based has not been shown to be distinct from either Smylodon or Felis.

In *Iemisch Listai* we have an instance in Zoological Science, which if not unique, it surely ought to be, of a species in which the original type may be fairly said to consist of traditions, collected among an entirely uncivilized people. For it is upon these Indian tales that the description given by Dr. Ameghino not only as to the habits but also as to the color, number and character of the toes on each foot, size of head, length and prehensile nature of tail, etc., are based.

Regarding the existence of such traditions among the Indians of Patagonia, I can only say that during the three years spent by myself there, during which I was frequently thrown among the southern Indians, I learned of no such traditions from the Indians themselves. If any such traditions exist among them, they certainly have not engendered that feeling of terror and fear of this animal as pictured by Ameghino, for I have frequently camped with the Indians in regions said by Ameghino to be the traditional or reported haunts of Iemisch, and have never observed them to take any special care for themselves or their horses, leaving the latter loose, picketed and hobbled in great numbers night and day alike.

From a study of the cave and the condition in which the remains were found, Dr. Hauthal concludes that man and all the other animals of which associated remains were found, coëxisted here during an interglacial period and that these caves were occupied as habitations by the men who shared them with certain domesticated animals among which was the large Edentate, *Grypotherium domesticum*. This opinion is also shared by Dr. Roth and less strongly, if I mistake not, by Dr. Nitsche who discusses the material from an archæologic standpoint.

The papers are extremely interesting and are important not only for the light they throw on the nature of the '*Mysterious Mammal of Patagonia*,' but also for the additional evidence afforded of the existence of representatives of the Pampean fauna in comparatively very recent times. We may expect further explorations of these cave deposits to bring to light additional remains and perhaps establish their correlation with deposits in the north.

J. B. HATCHER.

Maryland Weather Service. Volume I. Baltimore, Md., The John Hopkins Press. 1899. 4to. Pp. 566. Charts LIV. Figs. 61.

If the succeeding volumes of the Maryland State Weather Service are kept up to the standard and size of the first volume, and if the scheme of work outlined in the present publication is followed out, it is safe to say that a new era has opened for climatology in this country. That this rich promise for the future will be fulfilled no one can doubt who knows the men in charge of, and interested in the Maryland Weather Service, and who appreciates the peculiarly favorable position which this service occupies, carried on as it is under the joint auspices of the Johns Hopkins University and of the United States Weather Bureau.

The Director of the Service is Professor William B. Clark, of Johns Hopkins University, whose special interest in geology has never caused him to neglect the scientific study of meteorology. The Secretary and Treasurer is Professor Milton Whitney, Chief of the Division of Soils of the Department of Agriculture, who represents the Maryland Agricultural College, and is well known in connection with his work on the relations of soils to climate and crops. The Meteorologist in charge is Mr. F. J. Walz, of the United States Weather Bureau, who is

detailed by the Chief of the Bureau to supervise the Weather Service work in Maryland, and who has carried on this work most successfully for several years. Dr. Oliver L. Fassig, Instructor in Climatology in Johns Hopkins University, and also an official of the United States Weather Bureau, who contributes an important paper to this volume, has been doing most effective work at his university through his lectures, and through his unique but most valuable summer field courses in observational meteorology. Dr. Fassig was formerly Librarian of the United States Weather Bureau in Washington; he has had the advantage of study under the leading European meteorologists, and under Professor Cleveland Abbe, the foremost meteorologist in this country, and is doing a great deal to further the advance of scientific meteorology in the United States. Finally, Professor Abbe himself, although not officially connected with the Maryland Weather Service, has had a great interest in its work, and has shown his interest by recently presenting the whole of his valuable meteorological library to Johns Hopkins University. In addition to this most happy association of men, admirably equipped for their work, the Maryland Weather Service has had the heartiest coöperation on all sides from National and State scientific departments.

We have spoken at some length of the personnel of the Maryland Weather Service, because such men are bound to produce excellent results, and this is the secret of the high quality of the present volume, which is emphatically *bahnbrechend.* It remains for us to note, as briefly as may be, the contents of the book.

An *Introduction* by Professor Clark gives the chief facts regarding the establishment of the Weather Service, and discusses the scope of the work now being carried on, or proposed for the future. We agree thoroughly with the Director in his views as to the range of subjects which fall within the limits of climatologic study. We believe, with Professor Clark, that climate cannot be studied without a knowledge of the physiography of the region under discussion, and that the disposition of the rainfall, the relations of the climate to health and disease, the character of forest growth, the distribution of plant and animal life, the relations of climatic conditions to human life and activities, these, and still other topics, deserve treatment in a complete investigation of any climate.

A general report on the Physiography of Maryland follows the introduction. This report, by Dr. Cleveland Abbe, Jr., is just in the right place in the volume. A physiographic basis is essential to the scientific study of climates; therefore the surface features of a country need consideration before the meteorological data are discussed. Dr. Abbe's report is written from the point of view of the new geography, and is clearly the result of careful and extended study. Doubtless this report will shortly be reviewed in this JOURNAL, and further mention of it is therefore omitted. A word may, however, be said regarding the illustrations, in the way of maps, sections and heliotype views, which serve to give the student of climatology who has the misfortune not to know Maryland from his own observations, a vivid idea of the chief topographic features of the state.

Part III., a report on the meteorology of Maryland, was prepared, by direction of Willis L. Moore, Chief of the Weather Bureau, by Professor Cleveland Abbe, Dr. Oliver L. Fassig and Mr. F. J. Walz. The first paper, by Professor Abbe, concerns the *Aims and Methods of Meteorological Work especially as conducted by National and State Weather Services.* This paper is divided into several sections, the first of which, on *Dynamic Meteorology and its Applications*, deals with the history of weather maps, clouds and cloud charts, weather forecasts and analytical and experimental research work in meteorology. This section is illustrated by means of the Hydrographic Office colored cloud views, first published in 1897, and by means of a series of weather maps. Professor Abbe's interest in all that tends to the advancement of the higher meteorology is well known, and in this paper he has enumerated many problems for special research and observation, which we heartily commend to the attention of those teachers who are fortunate enough to have facilities which enable them to offer their students such work to do, and who have the students who wish to do the work. The second

section of Professor Abbe's paper concerns *Climatology and its Aims and Methods*, and deals chiefly with the relations of climate to vegetation. Some years ago Professor Abbe made a careful study of the latter subject, and, although he has never published any extended report upon it, he has often referred to the results to which his studies led him. We take it that these pages of the Maryland Weather Service volume contain a summary of the results which Professor Abbe reached, and we welcome them as giving the best brief statement of the most important facts in the complicated interrelations of climate and the products of the soil. Soil temperatures; the climatic influence of forests and agriculture; reforestation; the geographical distribution of plants, etc., are considered. The third section of Professor Abbe's report deals with *Apparatus and Methods*, and is the first publication on this subject we have yet seen which illustrates the different instruments altogether by means of photographic reproductions.

A Sketch of the Progress of Meteorology in Maryland and Delaware, by Dr. Fassig, follows, and is an extremely interesting historical account. We note, in passing, that Dr. Fassig reproduces Lewis Evans's map of 1749, which contained the famous statement concerning the movements of northeast storms from the southwest. A copy of the original map, published in 1747, Dr. Fassig was unable to find; he has therefore reproduced the second map, dated two years later. Credit has sometimes been given to Evans for the first statement of this important discovery, but it justly belongs to Franklin, as Dr. Fassig says. This paper contains a valuable bibliography of publications relating to the climatology of Maryland.

The final report, by Mr. F. J. Walz, an *Outline of Present Knowledge of the Meteorology and Climatology of Maryland*, is a very complete account, containing full tables and many figures and charts. We note, with pleasure, a classification of Maryland weather into types, illustrated by means of weather maps, for climatology does not become a living study until the weather phenomena which go to make it up are understood. Mr. Walz has given us a climatic account of Maryland which is brought quite down to date, and which may well be adopted as a model by those who discuss the climates of other states. Excellent shaded charts showing precipitation and isotherms for each month, for the seasons, and for the year, accompany the report. Figures 35–40 are new. They are weather wind roses, and show the weather and wind conditions when Baltimore is under the influence of a cyclone and anticyclone in different seasons. Figure 55, the advent of spring in Maryland, is also an interesting addition to our knowledge of the climate of the state.

We have exceeded the limits which we set for this review at the outset, but we believe that the volume under discussion has been given no more space in this JOURNAL than it deserves. Paper, press-work and illustrations are all of the highest grade.

R. DEC. WARD.

HARVARD UNIVERSITY.

Indicators and Test Papers, their Source, Preparation, Application and Tests for Sensitiveness. By ALFRED I. COHN, PH.G. New York, John Wiley & Sons. 1899. Pp. 224.

As stated on the title page, this work is "a *résumé* of the current facts regarding the action and application of the indicators and test papers which have been proposed from time to time, and are in present use in chemical manipulations."

Part I. (pp. 19) deals with the general considerations determining the choice of indicators, their applications and limitations, behavior in other than aqueous solutions, dissociating effect of solvents, theory of their action, etc.

Part II. (pp. 154) is devoted to a discussion of a great number (76) of indicators, including not only those in common use, but also a great many others whose use has been recommended from time to time. The arrangement is alphabetical throughout, the data for each indicator being arranged under the following headings: Synonyms, Source, Preparation, Properties, and Application.

Part III. (pp. 51), on Test Papers, records the preparations and properties of 74 varieties, and is followed by tables showing the relative sensitiveness of indicators and test papers, and a

tabular summary of the behavior of the most important indicators toward the more common acids and bases.

On the whole, the book is likely to prove useful in the laboratory for reference, as it is carefully compiled and brings into a compact and systematized form a great mass of scattered detail. Although 75 per cent. of the indicators and test papers recorded would probably never be used by the average chemist, yet, in special cases, where the ordinary indicators fail, it may prove a great convenience to have at hand such a compilation from which a suitable one may be selected. The educational value of the book, however, might in many cases be increased by the use of graphic formulas, especially in several of the syntheses which the author represents merely by equations.

The book is of a convenient size and attractive in form, the subject-matter is well arranged, printed on good paper with very clear type, but the proof-reading has been only fairly well done.

M. T. B.

Zur Analyse der Unterschiedsempfindlichkeit. By LILLIE J. MARTIN und G. E. MÜLLER. Leipzig, J. A. Barth. 1899. Pp. vii + 233. M. 7.50.

It is a psychological sign of the times that this work on the perception of weight does not in the least concern itself with Weber's law, but leaves that issue entirely aside in order to consider the psychological and physiological elements in the process. Instead of looking for the bare statistical result of a large number of judgments, it asks *how* a judgment is carried out. Accepting as a fundamental answer the theory of Müller and Schumann—according to which the process consists in lifting with equal muscular force the two objects to be compared, and inferring their relative weights from their resulting movements—accepting this theory without serious discussion, the authors seek for minor factors in the process. Their method is two-fold: to collect introspective observations made during the experiments, and to vary the conditions and contrast the statistical results. By these methods they have detected the following factors:

First, fatigue and its opposite, namely, excitation or 'Bahnung.' It may happen that lifting the first of a pair of weights fatigues the motor centers; if so the energy of the second lift will involuntarily be less than that of the first, and the second weight will seem heavier than it is. In other conditions of the neuro-muscular system, lifting the first weight does not fatigue but stimulates; the second lift is then more energetic than the first, and the second weight feels correspondingly lighter. This theory—for it is not so well established as the other points made by the authors—is advanced in explanation of the 'time-error.'

Many judgments, though purporting to consist in the comparison of two given weights, were found to be something quite different. Often they were based on 'side-comparisons.' The actual comparison was not between the two weights given to be compared, but between one of them and the corresponding weight of the preceding pair. Though this seems an indirect and far-fetched manner of judging, it is often more readily adopted than the direct comparison. And in other cases no genuine comparison at all takes place, but the judgment is based on an *impression of the absolute weight* of one of the lifted objects. After growing accustomed to the series of weights used in an experiment and getting one's movements adjusted to the average run of those weights, one often finds that a weight on being lifted feels light, or feels heavy. This feeling is not a definite comparison of the given weight with the average; it is a mere impression, yet often very reliable. The impression is stronger the more the given weight differs from the average; which means that the easiest and most confident and correct judgments are the most apt to be determined by the mere impression, and the least apt to be genuine comparisons. Practice by no means eliminates this way of judging; on the contrary, the best demonstrated effect of practice was to increase the dependence on these impressions.

The impression of absolute weight operates differently in two classes of persons. Those of strong muscles and energetic movements are more subject to the impression of lightness; the less energetic to the impression of heaviness.

A large part of the monograph is occupied with an attempt to follow in detail the combined

effect of these various factors. This is a sort of quantitative analysis, which, though of purely technical interest, would have its value for psychology, could we but be sure of our numerical basis. When unfortunately there are, as in the present instance, three or more variable factors at our disposal, no one of which is a determined function of any other quantity, the field for arbitrary assumption of values is so wide that we have no means of checking our computation.

The real value of the work is that it points out several incidental factors in the process of judging. The more closely actual judgments are studied, the more evident does it become that they do not proceed according to the clean logical schemes which we are prone to devise for them in advance.

R. S. WOODWORTH.

GENERAL.

THE American Museum of Natural History, New York City, proposes to publish a selection of photographs collected by members of the Jesup North Pacific Expedition, provided a sufficient number of subscriptions can be obtained to warrant the undertaking. The photographs are to be reproduced by the heliotype process, in large quarto form. The edition will be limited to 250 copies. It is intended to issue the album in parts of at least 24 plates annually, the whole series to embrace 120 plates. It is contemplated to publish during the first year a series illustrating Indian types from the interior of British Columbia.

THE University of the State of New York has issued Museum Bulletin 24, supplementing the report of the entomologist for 1898, which is a memorial of the life and entomological work of Dr. Lintner. This contains a consolidated index to his whole series of reports and gives a nearly, if not quite, complete list of his scientific contributions during a long series of years. This volume of 316 pages will be sent postpaid to any address for 35 cents. Bulletin 28 is a pamphlet of 202 pages on the plants of North Elba, which will be much appreciated by the frequenters of that beautiful region. Its price postpaid is 20 cents. In University Handbook 16, the State Entomologist explains the scope and public utility of his field of work. This series of handbooks gives in convenient form information frequently called for regarding the various divisions of the university work, and single copies are mailed free to any address.

BOOKS RECEIVED.

The Nervous System and its Constituent Neurones. LEWELLYS F. BARKER. New York, D. Appleton & Co. 1899. Pp. xxxii + 1122.

Chemistry, its Evolution and Achievements. FERDINAND G. WIECHMANN. New York, Jenkins. 1899. Pp. vii + 176.

The Family of the Sun, Conversations with a Child. EDWARD S. HOLDEN. New York, D. Appleton & Co. 1899. Pp. xxiv + 252. 50c.

Handbook of Practical Hygiene. D. H. BERGEY. Easton, Pa., The Chemical Publishing Co. 1899. Pp. 164.

NOTES ON INORGANIC CHEMISTRY.

THE larger works on descriptive chemistry are full of compounds whose existence is doubtful, and it becomes the sometimes thankless task of the chemists of to-day to go over this old work and verify or prove false the work of earlier observers. An instance of this appears in the last *Journal* of the Chemical Society (London) in the case of the suboxid of phosphorus P_4O. The existence of such a compound, discovered by Le Verrier in 1838 was, indeed, called in question by von Schrötter in 1852, as he considered it merely an impure form of the red ('amorphous') phosphorus, which had not long before been discovered by him. In 1880, however, Goldschmidt and Reinitzer prepared a red substance which resembled Le Verrier's 'suboxid' and the existence of P_4O seemed to be confirmed. But now Chapman and Lidbury have gone over the whole subject, have prepared and analyzed every substance which has been described by different observers as 'suboxid' and come to the conclusion that the supposed suboxid P_4O is identical with red phosphorus in a finally divided and superficially somewhat oxidized and hydrated condition. No compound of definite composition could be found.

THE problem of softening hard waters for industrial purposes is one of the great problems of applied chemistry. Such softening is not merely necessary for boiler waters, but it has

been shown recently that the saving in excess of soap consumed by a hard water will render it economical for a city to expend a considerable sum in softening a hard water supply. In a recent number of the *Journal* of the American Chemical Society, M. L. Griffin gives the details of a series of experiments in the use of several softening agents. Waters containing less than .025 grams lime and .007 grams magnesia cannot be appreciably purified, though harder waters can often be reduced below these figures by purification. Calcium carbonate is most effectively removed by sodium hydroxid, sodium fluorid, and in some cases sodium aluminate. Calcium sulfate and chlorid are best treated with sodium fluorid, which, however, has no effect on magnesium salts. Sodium hydroxid is the most useful reagent for magnesium salts, and barium hydroxid follows, but the latter is not satisfactory for waters containing a large proportion of calcium carbonate and sulfate.

IN the *Journal* of the Russian Chemical Society a new cerium mineral from the Caucasus is described by G. Tschernik, which from the analysis seems to be essentially a titanate and zirconate of cerium. It contains a gas which is 90% a mixture of nitrogen and argon. The mineral contains but .03% uranium and no helium. The ash of a coal from Tkwibuli, which was chiefly calcium sulfate, with alumina and silica, and about 10% of ceria, lanthana and didymia, showed the presence of over 1% of helium.

THE *Report* of the Australian Association for the Advancement of Science contains a description by Thomas Steel of a 'red rain' which fell over Melbourne and much of Victoria on December 27, 1896. The rain carried down an unusually heavy fall of dust of red color, which appeared on analysis to be an ordinary surface soil derived from volcanic rocks. Under the microscope the presence of diatoms, scales of lepidoptera, quartz and garnet were detected.

AN instance of the use of liquid ammonia as a solvent is shown by C. Hugot in the *Comptes Rendus*, where the selenids of sodium and potassium are thus formed. A mixture of selenium with the alkali metal is treated with liquid ammonia. If the metal is in excess the insoluble selenid Na_2Se or K_2Se is formed while if the selenium predominates a polyselenid Na_2Se_4 or K_2Se_4 is formed, which is dissolved in the ammonia and is obtained on its evaporation. Contrary to the observation of Franklin and Krauss, Hugot finds that selenium itself is insoluble in liquid ammonia. J. L. H.

TECHNICAL UNIVERSITY DEGREES.

A LETTER, recently received from Ex-President Andrew D. White, our Minister to Berlin, relative to matters educational, mainly, tells of the festival on the 100th anniversary of the founding of the great technical college at Charlottenburg, Berlin. This celebration, with its processions, its speech-making by the Emperor and other notables, and the structure and decorations of the great college buildings, have been fully described by press correspondents; but it has not been stated, so far as has been observed, except in a brief note in SCIENCE, that the Emperor, while erecting this splendid institution into a national, technical, university, making its powers those of the academic universities and its director a '*Rector Magnificus*,' conferred also the special power of giving the degree '*Dr. Ing.*,' doctor of engineering, a degree already established in this country, in 1884, at the initiative of the writer, and very sparingly conferred, to date, by the Stevens Institute of Technology.

The event, both as being the occasion of the formal institution of a national technical university, and as giving formal and official recognition to a degree which gives claim to full standing of the profession of Archimedes and Leonardo and the Marquis of Worcester, beside those of Hippocrates and of Justinian, was one of unusual importance and significance. This movement has been a vitally important part of that systematic programme which has led to the industrial triumph of Germany, of which Dr. White says in this letter: "It is amazing to see how, in their way, the Germans have gone steadily on until they have established a wonderful system of manufacturers all over their country and an astonishing commercial connection, through fleets of great steamers going to all parts of the world."

R. H. THURSTON.

LECTURES AT THE AMERICAN MUSEUM OF NATURAL HISTORY, NEW YORK.

THE following are the courses of lectures to be delivered at the Museum, during the present season:

A Saturday afternoon course by officers of the Museum to members, illustrated.

January 6th.—The Philippine Islands: Professor Albert S. Bickmore.

January 13th.—A Naturalist in Florida: Mr. Frank M. Chapman.

January 20th.—Results of the Third Season's Explorations for Dinosaurs in Wyoming: Professor H. F. Osborn.

January 27th.—A Hunt for Fossil Horses and Elephants in Texas: Dr. W. D. Matthew.

February 3d.—The Geology and Mineralogy of Greater New York: Dr. L. P. Gratacap.

February 10th.—The Yellowstone National Park: Dr. E. O. Hovey.

February 17th.—The Eskimo of Hudson Bay: Professor Franz Boas.

February 24th.—The Thompson Indians of British Columbia: Mr. Harlan I. Smith. (The Jesup North Pacific expedition.)

March 3d.—The Madu Indians of California: Dr. Roland B. Dixon. (The C. P. Huntington expedition.)

March 10th.—The Pre-historic Sculptures of Mexico and Central America, exhibited in the Anthropological Department of the Museum: Mr. M. H. Saville. (The Loubat collection.)

March 17th.—Pre-historic Ruins in New Mexico: Professor F. W. Putnam. (The Hyde expedition.)

A lecture on 'A Naturalist in Cuba,' by Mr. Frank M. Chapman, will be delivered under the auspices of the Linnæan Society, January 11th.

Two lectures will be given on January 18th and 25th under the auspices of the New York Mineralogical Club.

A course of four lectures, by Professor A. S. Bickmore, will be delivered on March 8th, 15th, 22d and 29th.

Two lectures will be given on April 5th and 12th, under the auspices of the New York Botanical Garden.

The Thursday evening course to members (illustrated) by Professor Bickmore is as follows:

Dec. 7th.—The Philippines, Manila and the Tagals.

Dec. 14th.—The Visayans and Sulus.

Dec. 21st.—The Hawaiian Islands, Honolulu.

Dec. 28th.—Kilenea and Haleakala.

The Columbia University lectures given in coöperation with the Museum, by G. W. James, are:

Dec. 2d.—Down the Canyons of the Colorado with Major Powell.

Dec. 9th.—Dynamic Geology of the Grand Canyon.

Dec. 16th.—The Pamtes Desert.

Dec. 23d.—The Mesas of Acoma, Zuni and Moki.

Dec. 30th.—The Canyons of the Cliff Dwellers. This course is continued by other lecturers every Saturday evening from January 6th until March 31st.

SCIENTIFIC NOTES AND NEWS.

PROFESSOR SIMON NEWCOMB has been elected a correspondent of the 'Bureau des Longitudes,' Paris, and a foreign member of the Royal Society of Lombardy.

THE Council of the Royal Society has awarded the Copley Medal to Lord Rayleigh, F.R.S., for his contributions to physical science, and the Davy Medal to Mr. Edward Schunck, F.R.S., for his investigations on madder, indigo and chlorophyll.

DR. A. H. DOTY, health officer of New York City, has returned from Europe, after several weeks spent in studying sanitary systems employed abroad.

WE learn from the *Botanical Gazette* that the international scientific medal of the Academie Internationale de Geographie Botanique has been conferred upon Dr. N. M. Glatfelter, of St. Louis, for his work upon *Salix*, and upon Dr. Roscoe Pound, of Lincoln, Nebr., for his phytogeographical researches. Fifteen investigators in Europe have been similarly honored.

MR. SHELFORD BIDWELL, M.A., LL.B., Gonville and Caius College, Cambridge, has been approved by the General Board of Studies for the degree of doctor in science.

HERR F. K. GINZEL, of the Bureau of Com-

putation of the Berlin Observatory, has been appointed to a professorship.

THE death is announced of Mr. Augustus Doerflinger, a well-known engineer, at Brooklyn, on November 24th, in his fifty-fifth year. He was a graduate of Cornell University, and in the service of the government had charge of the removal of Hell Gate in the Harbor of New York City, and other important engineering works.

DR. WILHELM ZENKER, the physicist, died in Berlin, on October 21st, aged seventy years.

THE botanist and philologist, Stephan Ladislaus Endlicher, who died in 1849, was buried along with his wife Cecilia in the Matzlemsdorfer Cemetery in Vienna. *Natural Science* quotes from a Vienna journal the statement that on the 21st of June, the bodies were removed to a worthier resting place near the main entrance to the central Friedhof. The Rector of the University, Professor J. Wiesner, and the Director of the Botanical Gardens, delivered short orations in praise of Endlicher's genius and the services which he rendered to botany, philology, and science in general.

A MEMORIAL of Professor Heinrich van Bamberger, formerly professor of medicine in the University of Vienna, was unveiled in the quadrangle of the University on October 29th. An address was delivered by Professor Neusser.

DR. BERTHOLD LAUFER has returned to Yokohoma from his expedition to the Amoor river and Saghalin, undertaken for the Jesup North Pacific expedition of the American Museum of Natural History, after an absence of nearly two years.

PROFESSOR JOHN MILNE, of Newport, Isle of Wight, has reported as follows to the trustees of the Elizabeth Thompson Science Fund: On February 19, 1898, the trustees of the Elizabeth Thompson Science Fund assigned me a grant of $250 in aid of a seismic survey of the world. This was expended in purchasing a horizontal pendulum, which was shipped to the care of H. M.'s Consul-General, W. J. Kenny, in Hawaii. When Mr. Kenny left Honolulu in March, 1899, the instrument was handed to Professor Maxwell, who will work in conjunction with Professor Alexander and Professor Hosmer (principal of the government high school), and the latter, I understand, will kindly make arrangements for its installation. Professor George Davidson, chairman of a committee appointed by the council of the University of California to undertake seismic investigations, writes me that Mr. Bishop, of Honolulu, has promised a site for the instrument, and that Professor Alexander will see that it is placed in working order. It is hoped that by next year a series of records will have been obtained from this exceedingly important station. Copies of the report based upon these records should be sent to the secretary of the board of trustees of the Elizabeth Thompson Science Fund, Harvard Medical School, Boston, Mass., through the liberality of which body the Hawaiian station has been established.

THE *Botanical Gazette* states that by the coöperation of a local mountain club, Dr. R. von Wettstein, the director of the Vienna Botanical Garden, has been enabled to establish a Biological Experiment Station in the Tyrolese Central Alps, near the 'Bremer Hütte' in the Geschnitzthal, at an elevation of 2,300 m. A room in the college has been fitted up for a laboratory. Research will be directed first to the production of species by direct adaptation.

IT is reported in *Natural Science* that an Association has been formed of collectors for the purpose of exploring the local lepidopterous fauna of Hildesheim and vicinity, under the title of *Verein für Schmetterlingsfreunde.* Professor A. Radcliffe Grote of the Roemer Museum presides.

THE first meeting of the 81st session of the Institution of Civil Engineers was held at its house, Great George-street, Westminster, London, on November 7th, when the new president, Sir Douglas Fox, took the chair and delivered his inaugural address. The speaker called attention to the fact that Great Britain is not holding its own in mechanical science, compared with the nations of the continent and with the United States, especially in the introduction of electricity for lighting, traction and transmission of power.

THE first scientific meeting of the Zoological Society of London for the session 1899–1900

took place at its house, 3 Hanover Square, on Tuesday, November 14th.

A MEETING of the Fellows of the Royal Botanic Society was held in the museum at the Royal Botanic Gardens, Regent's Park, London, on November 11th, Major Cotton presiding. He stated that the number of Fellows elected this year had been greater than in any previous year since the foundation of the Society. He added that the club, which was founded at the beginning of the year, had been very successful, and the members, limited as they were to Fellows of the Society, now numbered over 600. The series of dinners that had taken place in the summer were so largely attended that many had had to be turned away, and steps were consequently being taken to increase the accommodation. In connection with the club dinners, entertainments were now being given every Wednesday evening and the Fellows were cordially invited.

DR. TIESSEN'S scientific notices state that a bacteriological institute has been established by the Russian government in Wladiwostok, East Asia, and that one is planned for Merw in Central Asia.

IT is reported that the Russian Astronomical Society has finally given up its attempt to revise the Julian calendar. The reason assigned for its failure by the Society is "the impossibility of establishing an agreement between the dates of the religious festivals appearing in both calendars."

ACTING SUPERINTENDENT WILCOX, of the Yosemite National Park, in his annual report, recommends that the government buy out the owners of patented lands within the park limits. Other recommendations are the fixing of penalties for violation of the park regulations; obtaining authority from the state of California to establish a camp for troops within the Yosemite valley for patrol purposes, a permanent camp to be constructed at Wawona; a systematic burning of fallen and dead timber, to prevent forest fires; and some decisive action to prevent diverting the waters flowing into the park. The report says the deer are fairly plentiful and tame, bear, quail, squirrels and trout are numerous, and mountain lions and lynx are to be found.

A PRESS despatch from Washington states that the War Department is at work on the problem of wireless telegraphy for the signal service. The Signal Corps has been handicapped recently both by lack of funds and officers to experiment on an extensive scale, but Capt. Reiber, at Governor's Island, New York, is carrying on a series of experiments between that point and Tompkinsville, with a view to adapting the army apparatus for communication between fortified points and in any other locations where the wireless system might prove superior in practice to the older form of telegraphy. The army is not dependent on Marconi for instruments, having developed a system of its own, and the work will be pushed with vigor when Congress furnishes the necessary means.

COMMENTING on the failure of the British Government to use wireless telegraphy in South Africa *Nature* says: Science, and especially the latest developments of science, are the last things to interest our government and the government departments; they do not believe in science, they care to know very little about it, and the scientific spirit is absent from too many of their plans and doings. Hence we have now to be thankful that they have reached the level of the pigeon post, which has been the only official means, and that on the part of one or two birds, to keep us in touch with our beleaguered forces. It is stated that even the Commander-in-Chief, Lord Wolseley, has expressed some surprise that the so-called 'Intelligence Department' of the army allowed the Ladysmith force to go to the front with mountain guns against a Boer force which they should have known might be armed with Schneider-Canet cannons of large calibre; and it would seem that probably a terrible disaster has been prevented, not by our Intelligence Department, not by the outfit of our army, but by the apparently accidental arrival of naval guns and *personnel* at the last moment. Why is there not a Scientific Committee to do what it can in advising the military authorities? If they could do nothing, nobody would be the worse, but they might be able to do much to the nation's advantage.

UNIVERSITY AND EDUCATIONAL NEWS.

A friend of McGill University and of Sir William Dawson has communicated to the board of governors of the university his wish to endow a chair to be called the 'Dawson chair,' in memory of the late emeritus principal and eminent geologist, and has contributed money for that purpose, with the condition that Lady Dawson shall enjoy the income during her life.

Thomas Armstrong, of Plattsburgh, N. Y., who died in 1897, left his property amounting to $300,000 to Union College, Schenectady, N. Y. Suit was brought on behalf of his wife and children, and half of the estate has been awarded to them, while the remaining $150,000 goes to Union College.

Vassar College has recived a gift of $5,000 toward the proposed biological laboratory, for which $25,000 has been promised on condition that an equal additional sum shall be raised.

The report of the treasurer of Yale University shows that its invested funds have increased during President Dwight's administration of thirteen years from a little over $2,000,000 to nearly $5,000,000. This does not include the endowment of the Sheffield Scientific School, which is about $600,000. The income from invested funds has increased from about $113,000 to about $221,000, while students' fees have increased still more rapidly, namely, from about $150,000 to about $500,000. The permanent funds of the University were increased last year by nearly $100,000 and the building fund by about the same amount.

An influential meeting was held in the Senate house of Cambridge University on November 4th for the purpose of forming an association the objects of which are—(1) To establish and distribute information respecting appointments which can be appropriately filled by members of the association; (2) to establish and organize means of communication between candidates for such appointments and the persons or bodies making the appointments. Remarks were made by the Chancellor, by Lord Rothschild, and others. It was resolved "that an association be formed for facilitating the employment of graduates of the Uuiversity in the various professions and occupations for which they are fitted by their university training," and a board of management was appointed. There are similar committees at Oxford University and at Harvard and Columbia Universities.

The following past-list for the D.Sc., of the University of London, examination has been issued.

Mathematics. — John G. Leathem (Granville Scholarship), St. John's Coll., Cambridge.

Experimental Physics. — George B. Bryan, St. John's Coll., Cambridge, and Univ. Coll., Nottingham; Edgar W. Marchant (Granville Scholarship), Central Technical Coll., and pr. st.; Samuel R. Milner, Univ. Coll., Bristol, Inst. für Physik-Chemie, Göttingen, and Owens Coll.; Spencer W. Richardson, Trin. Coll., Cambridge, and Cavendish Laboratory.

Chemistry.—Martin O. Forster (Granville Scholarship), Royal Coll. of Science; Edwin C. Jee Central Technical Coll.; Thomas M. Lowry, Central Technical Coll.; Gilbert T. Morgan, Royal Coll. of Science; Robert H. Pickard, Mason Univ. Coll.

Botany.—Albert H. Trow, private study.

Employment of the Theory of Correlations in Biological and other Investigations.—Alice E. Lee, B.A., Univ. Coll.

Zoology.—James H. Ashworth, Owens Coll.; Ernest W. MacBride, Zoological Laboratory, Cambridge; Arthur T. Masterman, Christ's Coll., Cambridge, and St. And. Univ.

Geology.—Charles G. Cullis, Royal Coll. of Science.

Dr. Karl W. Geuthe has been appointed instructor in zoology in the University of Michigan.

At St. John's College Cambridge, the following fellows have been elected: Mr. W. A. Houston, fifth wrangler, 1896, lecturer in mathematics in University College, Liverpool, and Mr. Grafton Elliott-Smith, assistant demonstrator of anatomy in the University, who has made valuable contributions to the comparative anatomy of the brain.

Dr. C. Correns has been made assistant professor of botany in the University at Tübingen.

The following have qualified as docents in German universities: Dr. Bohumil Neuseč in plant anatomy and physiology in the Bohemian University at Prague; Dr. Wederkind in natural science in the University at Tübingen, and Dr. Dandler for anatomy in the University at Vienna.